

In the specifications OUA (Office of the University Architect) is referenced in the Designer's Notes for coordination purposes. Coordinate relevant items with the University's Project Engineer and/or Manager in these instances as applicable.

These Master Specifications are provided by Kent State University for use by the A/E to incorporate into projects. The intent of the Master Specifications is to formalize University requirements and standards for materials, equipment, and installations to provide continuity across projects.

The A/E is to use these specifications as a starting point for all Kent State projects. Not all specification sections provided will be needed for every project. The A/E shall select only the sections applicable to the project. Specification sections noted with an 'x' after the specification number are not full specifications, but rather an outline of requirements that the A/E is to incorporate into their own specification section to capture specialties and requirements of Kent State University. These are typically for more complex pieces of equipment that will likely require in-depth review with OUA during design.

The list of available specification sections is not inclusive of all specifications that may be needed for a complete project. The A/E shall supplement Kent State's master specifications with their own while including requirements of other relevant Master Specification sections as applicable.

The master specifications are to be reviewed and edited to suit the project. These specifications sections do not relieve the A/E of their professional responsibility to review, edit, and fully understand the documents. The A/E is ultimately responsible for the specification sections and must review any deviations, concerns, or questions with OUA.

Editor Notes are included to help guide the A/E of options to select.

Designer's Notes are also included at the end of many specification sections. These are specific design requirements to be reviewed and/or incorporated into the documents. These notes are from Kent State's Master Design Guidelines and shall be retained in their entirety on all design review submissions. The Designer's Notes shall be deleted from the final version of the specifications issued for bidding.

KENT STATE UNIVERSITY

MASTER SPECIFICATIONS

DIVISION 21

210500	Common Work Results for HVAC
210501	Basic Mechanical Materials and Methods for Fire Protection
210513	Common Motor Requirements for Fire Suppression Equipment
210517	Sleeves and Sleeve Seals for Fire Suppression
210518	Escutcheons for Fire Suppression Piping
210519	Meters and Gages for Fire Suppression Piping
210529	Hangers and Supports for Fire Suppression Piping and Equipment
210553	Identification for Fire Suppression Piping and Equipment
211100	Facility Fire-Suppression Water-Service Piping
211116	Facility Fire Hydrants
211119	Fire Department Connections
211200	Fire-Suppression Standpipes
211313	Wet-Pipe Sprinkler Systems

SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 GENERAL REFERENCE

Retain or edit sections below as they pertain to the project.

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to work of this section.
- B. Refer to Division 01 section "Alternates" for possible alternates affecting the extent of this Section of work.

Retain below only if it is applicable to the project. Coordinate Specification number below.

- C. Specification Section 018113.13 Sustainable Design Requirements apply to work specified in this section.
- D. Specification Section 018113c Indoor Air Quality Management Plan during construction apply to work specified in this section.
- E. This Contractor is also referred to the Plumbing, Architectural, Structural, Electrical and all other drawings and specifications pertinent to this project. All of the above mentioned drawings and specifications are considered a part of the Contract Documents.
- F. This section specifies the basic requirements for Fire Suppression installations and includes requirements common to more than one section of Division 21. It expands and supplements the requirements specified in sections of Division 01.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

Select one of the two paragraphs after coordinating with the Architect. Paragraph "A" is for one prime contractor, "B" is for multiple contractors.

- H. The term "Contractor" as applied to work specified, shown or reasonably implied in the contract documents for Division 21 shall be defined as the subcontractor who is responsible for the work specified or indicated. All subcontracted work must be incorporated by and coordinated by the prime contractor.
- I. The term "Contractor" as applied to work specified, shown or reasonably implied in the contract documents for Division 21 shall be defined as the each prime contractor who is responsible for the work specified, or indicated. All work subcontracted to each prime contractor must be incorporated by and coordinated by each prime contractor.

Use Paragraph "C" below if the Engineer is the lead design professional, "D" if the Architect is the lead. Fill in blank with Engineering firm.

- J. Throughout this specification section the term "Design Professional" is referenced. The specification calls for certain actions to be undertaken or referred to the Design Professional. Accordingly, the term "Design Professional" shall be defined as the firm with which the "Owner" has contracted to produce the contract drawings and specifications. It shall be understood that the Design Professional for this project is .
- K. Throughout this specification section the term "Design Professional" is referenced. The specification calls for certain actions to be undertaken or referred to the Design Professional. Accordingly, the term "Design Professional" shall be defined as the firm with which the "Owner" has contracted to produce the contract drawings and specifications. It shall be understood that the Design Professional for this project is the Architect whose name is shown on the drawing title block.

1.3 QUALITY ASSURANCE

- A. Electrical Characteristics for Fire Protection Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at the expense of the Fire Protection contractor. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.4 FIRE SUPPRESSION COORDINATION

- A. This Contractor shall familiarize himself with the work to be done under other Divisions of this specification and their related drawings and shall so coordinate and schedule his work as not to cause delays or interference with the work of others. Such coordination and scheduling shall

accomplish the installation of equipment and piping with a minimum of cutting through masonry and other adjustments.

- B. Ceiling grid systems shall not be supported from fire protection lines or any other utility lines, and vice versa. Each utility and the ceiling grid system shall be a separate installation and each shall be independently supported from the building structure-concrete, steel or masonry.

The following requirement for each contractor to be responsible for their own openings is preferred. Coordinate with Architect and Section 210501.

- C. This Contractor shall be responsible for proper size and location of anchors, chases, recesses, openings, etc., required for the proper installation of his work. Verify all dimensions by field measurements. Coordinate the installation of required supporting devices and sleeves in structural components as they are constructed. Sequence, coordinate, and integrate installations of fire suppression materials and equipment for efficient flow of the work.
- D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors.
- F. Coordinate requirements for access panels and doors for fire protection items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- G. Allow ample space for removal of all parts that require replacement or servicing. Extend all grease fittings to an accessible location. Install equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with a minimum of interference with other installations. Sequence, coordinate, and integrate installations of fire protection materials and equipment for efficient flow of the work.
- H. All fire suppression equipment, especially piping, shall be at least three feet away horizontally from any electrical switchgear or transformers. No hydronic lines shall pass through telephone, transformer, switchgear rooms or elevator equipment rooms.
- I. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

Coordinate the following items with the Architect and edit accordingly.

- J. Specific divisions of responsibility when coordinating with trades other than fire suppression shall be as indicated on drawings, in Division 01, and as follows. The Contractors under this Division shall:
 - 1. Run the indicated utilities outside the building to points as noted on the drawings. He shall be responsible for the actual tie-in to street utility services where routing to site utility services on drawings pertaining to this Division are indicated.
 - 2. Provide and place all sleeves in floors, walls, etc., and coordinate such location.
 - 3. Rough-in and connect all equipment furnished by other trades or Owner where shown on the drawings.

4. Provide motors, special controls, transformers and relays as required for the proper operation of all equipment furnished by him under this Division.
5. Coordinate the location of floor drains and cleanouts with architectural and structural elements or work of other trades affecting the location of floor drains and cleanouts. Where floor drains are installed to serve specific pieces of equipment, coordinate the location of floor drains with the contractor who is providing the equipment, using manufacturer's shop drawings for the equipment served or written instructions from the equipment manufacturer.

1.5 EXAMINATION OF SITE

- A. Before submitting a bid, the Contractor is requested to visit the job site to familiarize himself with construction conditions. No consideration or remuneration will be given for his failure to do so.

1.6 DIVISION 21 DESIGN DOCUMENTS

Select one of the following two paragraphs. "A" is for projects with one Prime Contractor. "B" is for projects with multiple Prime Contractors.

- A. Should it appear that there is a discrepancy between or within the drawings and/or specifications concerning the nature, quality or extent of materials or work to be furnished and/or installed, and such discrepancy is not clarified by Addendum during the bidding period, this Contractor shall base his bid on performing the work in the manner having the higher cost. The Design Professional shall have the option of selecting either of the manners shown and/or specified. In the event the lower cost manner is selected, a credit shall be due the Owner in the amount of the difference between the lower cost and higher cost manner. Any discrepancies shall be called to the attention of the Design Professional before proceeding with work affected thereby.
- B. Should it appear that there is a duplication on the Drawings or in the Specifications, wherein the same work or items are shown or specified as being provided under different contracts, subcontracts or supply orders, and such duplication is not clarified by Addendum during the bidding period, it shall be assumed that the prime contractors have included duplicate quotations in their proposal to the Owner. The Design Professional shall have the option of selecting the contract, subcontract or supply order under which the work or items are to be provided and a credit shall be due the Owner for the duplicate work or items.
- C. Where a discrepancy exists within the specifications, among the drawings, or between the specifications and the drawings, refer to project supplementary conditions.
- D. Should it appear that there is a duplication on the drawings or in the specifications, wherein the same work or items are shown or specified as being provided under separate subcontracts or supply orders, and such duplication is not clarified by addendum during the bidding period, it shall be assumed that the responsible prime contractor will select and coordinate which subcontract will supply the item and the item will be supplied as indicated. Occasionally, certain references may be indicated on the Drawings to items which are suggested to be furnished and/or installed by various subcontractors. This is done to assist the applicable Prime Contractor in organizing his subcontractor's bids. However, no attempt has been made, nor is it implied, that this specification or plans are attempting to specifically divide all responsibilities for subcontractors. It is the Prime Contractor's responsibility that all items covered on Fire

Suppression plans and Division 21 specifications are included in his bid and are coordinated with his subcontractors. No consideration will be given for Prime Contractor's failure to include all applicable fire suppression work in his bid.

- E. The design drawings, as submitted, are diagrammatic and are not intended to show exact location of equipment, piping and ductwork unless dimensions are given. Drawings are not to be scaled.
 - 1. Equipment shall be installed along the general arrangement indicated on the drawings, and in accordance with the manufacturer's instructions.
 - a. Provide at least the minimum manufacturer's recommended and code required clearance around the equipment for normal maintenance.
 - b. Locate and arrange equipment in relationship to other system components to assure that the equipment will be operating under the best possible conditions to meet the scheduled performance requirements.
 - 2. Piping is to be installed along the general plans shown on the drawings keeping in mind the constraints of the available space and the need to coordinate with the work of other trades. Additional offset and fittings shall be provided as necessary to meet space constraints and to facilitate the work of other trades.
 - a. Recognizing the potential need for additional offsets and fittings in piping, the Engineer has included a safety factor in all friction calculations. The Contractor is advised to plan and coordinate his work carefully to minimize the need for additional offsets and fittings. The Contractor shall be responsible to notify the Engineer of any and all modifications to systems which may affect the ability of equipment to serve its intended use prior to the purchase and installation of such equipment.
- F. All equipment, piping and material specified hereinafter as shown on the drawings shall be furnished and installed by this Contractor, unless specifically indicated to the contrary.
- G. If this Contractor proposes to install equipment requiring space conditions other than those as specified and/or shown on the design drawings, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall obtain the full approval of the Design Professional before proceeding with the work.

1.7 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements of this division, and in Division 01.
- B. This Contractor shall record all changes from original design drawings which were made during the installation of the work. These changes shall be recorded in red ink on a designated set of prints. Changes shall be accurately dimensioned and/or drawn to scale.
- C. This Contractor shall keep an updated set of specifications and prints, including changes on the job site, at all times and shall submit one (1) set of updated and legible prints to the Design Professional when the work is complete.

1.8 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades under this Division shall submit coordination drawings in AutoCAD, drawn to scale for review. Refer to project schedule for required submission dates. Such drawings will be required throughout all areas for all trades. The requirements for Coordination Drawings are specified in Division 23 and are reprinted below:
1. The HVAC Contractor shall prepare the base plan coordination drawings showing all ductwork, all pertinent heating piping and equipment. The drawings shall be coordinated with lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearances, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Architect and Engineer. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of contract. Minor revisions need not be redrawn.
 2. HVAC Contractor shall provide the base plan in AutoCad and submit the base plan to all major trades' Contractors. All ductwork and piping shall be on separate layers.
 3. The Fire Protection Contractor shall draft location of piping, sprinkler heads and equipment on the base plan using a separate layer, indicating areas of conflict and suggested resolutions.
 4. The Plumbing Contractor shall draft location of all piping and equipment on the base plan using a separate layer.
 5. The Electrical Contractor shall draft location of lighting fixtures, cable trays, and feeders over 2 in. on the base plan using a separate layer, indicating areas of conflict and suggested resolution.
 6. The HVAC Contractor shall then combine all layers on a composite AutoCad drawing indicating all areas of conflict.
 7. The General Trades Contractor shall indicate areas of architectural/structural conflicts or obstacles and coordinate to suit the overall construction schedule.
 8. The Construction Manager shall expedite all drawing work and coordinate to suit the overall construction schedule. He shall then review these drawings and compare them with the architectural, structural, equipment and other drawings and determine that all of the work can be installed without interference. In the case of unresolved interferences, he shall notify the Architect. The Architect will then direct the various Contractors as to how to revise their drawings as required to eliminate installation interferences.
 9. If a given trade proceeds prior to resolving conflicts, then, if necessary, that trade shall change its work at no extra cost in order to permit others to proceed with a coordinated installation. Coordination approval will be given for individual areas after special site meetings involving all Trades.
 10. Coordination drawings are intended for the respective Contractor's use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these contract documents.
 11. After resolution of all conflicts, all trades shall sign and date a hard copy of the composite coordination drawing.

1.9 SHOP DRAWINGS

- A. Refer to the conditions of the Contract (General and Supplementary) and Division 01 Section: Shop drawings, product data, and samples for submittal definitions, requirements, and procedures. Refer to project schedule for required submission dates.

Retain above if there is a Division 01 specification with the project. If not, include the paragraph below.

- B. Submit electronic copy of shop drawings to the Design Professional.
- C. This Contractor shall review, stamp and sign with his approval and submit, with reasonable promptness and in orderly sequence so as to cause no delay in the work or in the work of any other Contractor, all submittal information required by the contract documents. Shop drawings not stamped with Contractor approval will be returned for reprocessing.
1. Shop drawings shall only cover equipment or components that are being provided. Failure to edit shop drawings and options will be reason for rejection.
 2. In approving the submittals, the Contractor guarantees that the submittals accurately and completely represent the equipment and materials to be installed.
 3. Shop drawings shall be submitted for ALL material items as outlined in these specifications. Any deviations from contract requirements must be clearly indicated on shop drawings, and justification for their consideration must be included.
 4. Acceptance of submittal items will not preclude rejection of those items upon later discovery that their suitability for the application or ability to meet the requirements of these specifications was misrepresented in the submittals.
 5. Equipment shop drawings shall include nameplate data, model number and efficiency rating along with full load amps for all electrical motors.
 6. Submittals for equipment shall include detailed dimensional drawings which completely and accurately represent the specific piece of equipment to be supplied. When more than one piece of similar equipment is to be supplied, provide accurate dimensional drawings for each unique size and/or configuration of the equipment.
- D. In checking shop drawings, the Design Professional will make every effort to detect and correct errors, omissions and inaccuracies in such drawings, but his failure to detect errors, omissions and inaccuracies shall not relieve the Contractor of responsibility for the proper and complete installation in accordance with the intent of the Contract Documents.

1.10 EQUIPMENT

- A. Before entering into a contract, the successful bidder may be required to submit satisfactory evidence to show that the manufacturer of all parts of the equipment offered have been regularly engaged in the manufacture of such equipment for three (3) years and have not less than three (3) installations of a similar type which have been in successful operation under conditions similar to those specified for not less than two (2) years.
- B. When two or more items of same equipment are required (pumps, valves, etc.) they shall be of the same manufacturer.

- C. In placing his bid, the Contractors under this Division shall take note that manufacturer's products change frequently, and only the scheduled products have been checked by the Engineer for compliance with the Contract Documents and physical characteristics. Other manufacturers are listed because they are believed to be capable of complying, and in order to achieve fair and competitive bidding. However, it is the responsibility of the manufacturer in his relationship with the Contractor to bid to the Contractor only products complying with the Contract Documents, and the responsibility of the Contractor to base his bid only on manufacturers which do comply. No consideration will be given to the Contractor for his failure to do this. Should Contractors during the bidding process discover that listed manufacturers cannot comply with the Documents, they are encouraged to contact the Engineer as soon as practical, and provided sufficient time in the bidding process exists, and the Engineer agrees with the request, the Engineer will attempt to adjust the documents in the addendum process. If no addendum is issued adjusting the requirements so that all listed manufacturers can bid, the Contractor will be required to supply one of the listed manufacturers which comply with the Contract Document requirements.

1.11 SUBSTITUTIONS

- A. Refer to the Instructions to Bidders and the related Division 01 sections for requirements in selecting products and requesting substitutions.

Make sure Division 01 addresses substitutions, if not include paragraphs B&C below. If covered in Division 01, delete paragraphs B&C.

- B. Bids concerning the use of substitute products must be accompanied by complete specifications and performance characteristics covering these products, together with such available test data and experience records as may be helpful to the Design Professional in evaluating the quality and/or suitability of the proposed products.
- C. The intent of this paragraph is to make the specifications open to all available makes of material and apparatus during the bidding period. Certain definite makes or kinds of items are specified as "standards of quality" and character required. Each Contractor is required to bid upon the basis of furnishing the makes specified. He is also invited to bid on any other similar makes he (the Contractor) may desire to propose as substitutions, stating any difference in cost for each proposed substitution on the Substitution Sheet, if there is a difference. If the Design Professional shall decide to accept any of the proposed substitutions, proper notations thereof shall be made in the written contract. Where several makes are mentioned in the specifications and the Contractor fails to state that he prefers a particular make in his bid, the Owner shall have the right to choose any of the makes mentioned without change in price. No consideration will be given to proposals for alternative products unless submitted with the original bids.

1.12 SUPERVISION

Coordinate whether a full time superintendent is required for the project. Typically required when this contractor is the Prime Contractor.

- A. The Fire Suppression Contractor shall have in charge of work at all times during construction, a competent foreman or superintendent whose experience and background shall qualify him for the work to be performed under this division. Once assigned, the foreman or superintendent shall be retained until completion of the project and any consideration as to his removal on grounds of incompetence shall either be initiated by or referred to the Design Professional for decision.

Contractor is to provide a resume for the superintendent/foreman with prior approval by the owner.

1.13 CODES AND PERMITS

- A. All equipment, materials, and installation shall comply with the National Fire Protection Association's "National Fire Codes" and "National Electrical Code". Equipment shall bear the "UL" label as required by these codes.
- B. Install work in full accordance with rules and regulations of State, County and City authorities having jurisdiction over premises. This shall include safety requirements of Ohio State Department of Industrial Relations. Do not construe this as relieving Contractor from compliance with any requirements of specifications which are in excess of Code requirements and not in conflict therewith.
- C. Unless otherwise indicated, secure and pay for all permits and certificates of inspection incidental to this work required by foregoing authorities. Be responsible for payments to all public utilities for work performed by them in connection with provision of service connections required under this DIVISION of specifications. Deliver all certificates to Design Professional in duplicate.
- D. The contractor shall be required to comply with OSHA requirement for physical hazards, safety equipment, fire fighting equipment and protective equipment.
- E. Belt guards, coupling guards, rails, roof fall protection, etc. shall be provided to meet OSHA requirements. Vent shafts and vertical openings shall be enclosed and comply with all OSHA requirements.

1.14 INTERFERENCES

- A. Before installing any work, this Contractor shall see that it does not interfere with clearance required for finish on beams, columns, pilasters, walls or other structural or architectural members, as shown on Architectural Drawings. If any work is so installed and it later develops that Architectural design cannot be followed, Contractor shall, at his own expense, make such changes in his work as the Design Professional may direct to permit completion of Architectural work in accordance with plans and specifications.
- B. Install additional offsets on piping where required to obtain maximum headroom or to avoid conflict with other work without additional cost to the Owner. Where mounting heights are not detailed or dimensioned, install fire suppression services and overhead equipment to provide the maximum headroom possible.
- C. Report any interferences between work under this division and that of any other Contractors to the Design Professional as soon as they are discovered. The Design Professional will determine which equipment shall be relocated, regardless of which was first installed, and his decision shall be final.

1.15 SHOP AREAS AND MATERIAL STORAGE

- A. No fire suppression related trade is permitted to use as shop working area, any concrete slab that is to receive metallic waterproofing, asphalt tile, plastic tile, etc., except by express permission of the Design Professional.
- B. The Contractor shall make provisions for the delivery and safe storage of his materials and equipment in coordination with the work of others. Materials and equipment shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected. The arrival and placing of large equipment items shall be scheduled early enough to permit entry and setting when there is no restriction or problem due to size and weight. Stored piping, and equipment to be covered and sealed at all open ends.

1.16 CLEAN-UP

- A. Refer to the Division 01 for general requirements for project cleaning. Contractor is responsible for cleaning each day.
- B. Insofar as the Fire Suppression work is concerned, at all times keep premises and building in neat and orderly condition, follow explicitly any instructions of Design Professional in regard to storing of materials, protective measures, cleaning-up of debris, etc.
- C. Upon completion of work, this Contractor shall thoroughly clean all apparatus furnished by him, pack all valves and thoroughly clean piping, ductwork and equipment removing all dirt, grease and oil.
- D. All equipment to be thoroughly cleaned prior to startup.

1.17 OPERATING AND MAINTENANCE

- A. This Contractor shall furnish competent personal instruction to the Owner's operating personnel for a period of hours as indicated in individual Division 21 specification sections in the proper operation of the fire suppression equipment. He shall also supply the Owner with three (1) hardbound copies of an operation manual bound in a transparent vinyl sleeve on the front of the binder and binder edge to protect labeling and (1) electronic copy in "PDF" format on disk. The manual shall be labeled on the front as well as the binder with the project name, project number, and the trade covered (i.e. "Fire Suppression", etc.). The operating and maintenance manual shall include the following:
 - 1. Cover sheet with project name, number, and contractor.
 - 2. Contractor and sub-contractor contact and phone list.
 - 3. Contractor warranty, indicating date of final acceptance.
 - 4. Equipment and material warranties and guarantees.
 - 5. Contact names and phone numbers for each product.
 - 6. Table of contents.
 - 7. Tabbed sections for each topic included in the manual.
 - 8. Complete equipment list with model and serial number.
 - 9. Manuals shall indicate all local suppliers of equipment.

10. Step-by-step procedures for start-up and shutdown for each system and piece of equipment.
11. Performance data, curves, ratings.
12. Wiring diagrams.
13. Manufacturer's descriptive literature.
14. Automatic controls with diagrams and written sequence of operation.
15. Manufacturer's maintenance and service manuals.
16. Spare parts and replacement parts list for each piece of equipment.
17. Name of service agency and installer complete with an emergency service phone number for nights, weekends and holidays.
18. Final approved shop drawings indicating actual device/equipment provided, not generic product data.
19. Final approved balance reports.
20. Final Operating parameters (Pressures, GPM etc.).

1.18 WARRANTIES

- A. Refer to the Division 01 Section: Specific Warranties for procedures and submittal requirements for warranties. Refer to individual equipment specifications for additional warranty requirements.
- B. Furnish to owner two (2) hard copies and (1) electronic in "PDF" format along with contact names, phone numbers, and email address for each product.
- C. This Contractor shall warranty all materials, workmanship and the successful operation of all equipment and apparatus installed by him for a period of one year from the date of the final acceptance of the entire work and shall guarantee to repair or replace at his own expense any part of the apparatus which may show defect during that time provided such defect is, in the opinion of the Design Professional, due to imperfect material or workmanship and not to carelessness or improper use. Compile and assemble the warranties specified in Division 21 into a separated set of vinyl covered three-ring binders, tabulated and indexed for easy reference.

1.19 TEMPORARY SERVICES

Elaborate on temporary services in Division 01, not this section. Make sure to cover utility charges in Division 01. Review the use of permanent equipment with Owner.

- A. The Contractor under this division shall provide temporary services, i.e.: as specified herein or in Division 01 "General Conditions" and "Special Conditions" portions of this specification.

1.20 PROTECTION OF WORK AND PROPERTY

- A. The Contractor shall be responsible for safeguarding work, property and facilities against damage, both his own as well as others, with which he may come into contact in the performance of his work.
- B. Stored materials shall be protected against damage from weather. Pipe openings shall be closed with caps or plugs during installation. All fixtures and equipment shall be covered and protected against injury. Any materials or equipment damaged at any stage in the construction shall be

replaced or repaired, and at the final completion of all work shall be in a clean, unblemished condition.

1.21 CUTTING AND PATCHING

Retain paragraph below only if Division 01 is included in the project.

- A. Refer to the Division 01 Section: CUTTING AND PATCHING for general requirements for cutting and patching.
- B. Do not endanger or damage installed Work through procedures and processes of cutting and patching. Arrange for repairs required to restore other work, because of damage caused as a result of fire suppression installations. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

If Division 01 is used, coordinate if Division 21 Contractors are to do their own cutting and patching with Architect. Usually, Division 21 cut and patch should be by the Division 21 Contractors.

- C. The contractor under this division shall perform cutting, fitting, and patching of building components and fire suppression equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work;
 - 2. Remove and replace defective Work;
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents;
 - 4. Remove samples of installed Work as specified for testing;
 - 5. Install equipment and materials in existing structures;
 - 6. Upon written instructions from the Design Professional, uncover and restore Work to provide for Design Professional observation of concealed Work.
- D. See other sections of this specification for demolition requirements.
- E. Pipe holes in floors and walls shall be core drilled if not sleeved during construction.

Retain below only if it is applicable to the project.

1.22 INTERRUPTION OF SERVICE

- A. When work progress makes temporary shutdown of services unavoidable, shutdown shall be coordinated with and approved by Owner so as to cause minimum disruption to established operating routine. Arrange to work as necessary to re-establish service within shortest possible down time. In those instances where the length of time required for the service interruption is not acceptable to the Owner, unless otherwise indicated, furnish and install temporary connections as required to reduce the length of time of service interruption to an acceptable level. Provide advanced notification a minimum one week in advance for approval.

Retain below only if it is applicable to the project. Coordinate LEED points and reference numbers.

1.23 LEED DOCUMENTATION

- A. Contractor to refer to LEED IEQ C4.1 & C4.2 Low-Emitting Materials. Provide submittals showing compliance as follows:
1. Product Data for Credit IEQ 4.1: For adhesives and sealants used, documentation including printed statement of VOC content. Refer to Division 01 Section "Sustainable Design Requirements" for additional procedures governing sustainable design.
 2. Product Data for Credit IEQ 4.2: For paints and coatings used, documentation including printed statement of VOC content. Refer to Division 01 Section "Sustainable Design Requirements" for additional procedures governing sustainable design.

PART 2 - PRODUCTS (Not Applicable to this Section)

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.3 TESTS AND ADJUSTMENTS

- A. Upon completion of the erection of all equipment and all work specified herein and/or shown on approved drawings, or at such times as directed by the Design Professional, this Contractor shall start all apparatus, make necessary tests as directed and as specified herein and make complete adjustments of all items of equipment before acceptance by the Design Professional to whose representative this Contractor shall demonstrate (by performance) all of the various apparatus and equipment.
- B. When the Contractor is ready to run capacity tests, he shall notify the Design Professional. When this notice is given, the Design Professional will assume that the Contractor has made preliminary tests and is satisfied that the plant will develop specified and guaranteed capacities. It will be the Contractor's responsibility to furnish any and all instruments required to obtain test data which shall include thermometers, electric meters, pressure gages, etc.
- C. Work under this division of the specifications shall not be considered complete until the Contractor has obtained required inspection, performance tests, made necessary adjustments and has submitted satisfactory evidence of compliance. The Design Professional or his representative will make spot checks to determine the accuracy and completeness of final adjustments. Should spot checks indicate more than a reasonable deviation from design requirements, the Contractor shall repeat tests and adjustments to the satisfaction of the Design Professional.

3.4 PUNCHLISTS

- A. From time to time throughout the course of the work, or upon completion of the work the Design Professional may perform site observations resulting in written documentation of deviations in the work from the Contract Documents. In such cases the Contractor shall respond in writing to each and every item on this written documentation stating the specific action taken to remedy the deviation. A response shall be provided by the Contractor for each separate observation. This work shall not be considered complete until such satisfactory written response is received by the Design Professional.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENATAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Each shop drawing is to be labeled with project name, specification number, and KSU project number.
- C. Warranties to be provided in an electronic list in Excel spreadsheet format.
- D. Draining or Chemical Cleaning of any Closed Loop Chilled Water, Steam and Steam Condensate Systems, Glycol Systems, Closed Loop Heating Water, and Cooling Tower Water Systems to the City of Kent's sanitary system is prohibited, without filling for a discharge drainage permit. Mandatory two week notice to dump will be required with an approved signed document from the City of Kent. KSU submits required forms to city, however contractor must provide onsite personnel contact information and estimated volume of discharge that will be drained. KSU would prefer that the designing engineers require reclaim methods be implemented versus dumping, unless no other options are possible. Compliance with these requirements will be required in your base of design for any project on the Kent Campus.

END OF SECTION 210500

SECTION 210501 - BASIC MECHANICAL MATERIALS AND METHODS FOR FIRE PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.
- B. Requirements specified in Division 21 Section "Common Work Results for Fire Protection" apply to this section.
- C. Requirements of Division 03 specification sections apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of Fire Protection related work required by this section is indicated on drawings and/or specified in other Division 21 sections.

Retain below if applicable. Coordinate excavation and backfilling with the Architect. Use Paragraph "B" if this contractor is to perform (preferred) or "C" if by the general contractor.

- B. Except as noted in this specification, this Contractor shall do all excavating and backfilling necessary to the work of this Division.
- C. This Contractor is to coordinate all excavating and backfilling required under this Division with General Trades as specified under Division 03.
- D. See specification Division 09 for painting requirements. Coordinate all Fire Protection painting work required. Coordinate protection requirements for Fire Protection equipment which could be damaged by paint.

Retain above if Architect is specifying painting, otherwise use paragraph below.

- E. This Contractor shall perform all painting incidental to this work.
- F. Furnish and install all miscellaneous steel required for supports, hangers, anchors, guides, etc., required for installation of equipment and materials furnished and installed under this Division. Steel used in a moist environment shall be hot dipped galvanized unless otherwise noted.

Coordinate concrete requirements with Architect. Select one of the following two paragraphs.

- G. This Contractor shall furnish and install concrete foundations or bases under all equipment that rests on floors in Mechanical Equipment Rooms. Follow drawings and/or manufacturer's literature with regard to design and construction of same.
- H. This Contractor shall provide to the General Trades Contractor dimensions and special requirements for the concrete foundations or bases under all equipment that rests on floors in

Mechanical Equipment Rooms. Follow drawings and/or manufacturer's literature with regard to design and construction of same.

Review with Owner and edit accordingly.

- I. This Contractor shall perform all Division 21 related and indicated selective demolition including nondestructive removal of materials and equipment for re-use or salvage as indicated. Unless otherwise indicated, dismantle Fire Protection materials and equipment made obsolete by these installations. All equipment removed shall be offered to the Owner for his retention. If the Owner elects to retain equipment, it shall be turned over to the Owner at the site. If not, the equipment shall be removed from the premises by this Contractor.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. Concrete Work Codes and Standards: Comply with governing regulations and, where not otherwise indicated, comply with industry standard, in its application to work in each instance.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including the recommended installation method, all in accordance with Division 01 and Section 210500 requirements.

PART 2 - PRODUCTS

Retain below only if this contractor is responsible for concrete work.

2.1 MATERIALS OF DIVISION 21 CONCRETE WORK

- A. Reinforcing Materials:
 1. Reinforcing Bars: Except as otherwise indicated, provide ASTM A 615, deformed, Grade 40 for size numbers 3 through 18; ASTM A 675, plain, Grade 60, for size number 2; sizes as indicated or required.
- B. Reinforcement Supports: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Provide wire bar type supports complying with CRSI recommendations, unless otherwise indicated.
- C. Concrete Materials:
 1. Portland Cement: ASTM C 150, Type I, except as otherwise indicated.

2. Aggregates: ASTM C 33, except as otherwise indicated.
 - a. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used.
 - b. For rough grouting, provide aggregate which is well graded and 100 percent passing through 3/8" sieve.
3. Water: Clean and free of substances harmful to concrete.

2.2 DESIGN AND PROPORTIONING OF CONCRETE MIXES

- A. General: Design Fire Protection work concrete as follows, for each 28-day compressive strength class:

Select 4000 psi for supporting large tanks or for beams, 3000 psi for equipment pads and foundations, 2550 psi for filling inertia bases, backfill class for rough backfilling with concrete.

1. 4000 psi Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.35 water/cement ratio.
 2. 3000 psi Class: 500 lbs of cement per cu. yd. (5.25 sacks), and 0.46 water/cement ratio.
 3. 2500 psi Class: 450 lbs. of cement per cu. yd. (4.75 sacks), and 0.54 water/cement ratio.
 4. Backfill Class (Lean Concrete): 375 lbs of cement per cu. yd., (4.0 sacks), and 0.60 water/cement ratio.
 5. Rough Grouting Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.60 water/cement ratio.
- B. Mix for Patching: Where Fire Protection work requires patching of exposed concrete work which has been cut to accommodate Fire Protection work, provide concrete patching mix which is identical with mix of work being patched (same cement, aggregates, admixtures and proportioning).

Retain below if excavation is required by this contractor.

2.3 EXCAVATING FOR DIVISION 21 WORK:

- A. Backfill Materials:

1. All backfilling within the building shall consist of an initial 12" layer of sand over the pipe. The remainder of the backfill shall be coarse interlocking aggregate or limestone screenings.
2. All backfilling outside the building shall be interlocking limestone aggregate or limestone screenings.

Include this section below only if Fire Protection is to provide painting.

2.4 GENERAL DIVISION 21 PAINTING PRODUCT REQUIREMENTS:

- A. All exposed insulation in occupied areas (and elsewhere, as indicated) shall be painted at the time of installation with one coat of water base paint. At the completion of the work all such insulation shall be given an additional coat of alkyd resin paint of a color to match existing building structure, or as selected by the Architect/Engineer.
- B. All uncovered ferrous pipe, fittings, exposed threads of galvanized pipe, non-factory painted portions of valves, hangers, structural steel, expansion tanks, and all other ferrous work shall be thoroughly cleaned and given two coats of alkyd resin paint of a color as selected by the Architect/Engineer.
- C. All general equipment and materials so indicated on the drawings as work to be painted by this contractor shall be thoroughly cleaned and given two (2) coats of a color as selected by the Architect/Engineer.
- D. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - Devoe and Reynolds Co. (Devoe).
 - Glidden Coatings and Resins, Div. of SCM Corporation (Glidden).
 - Benjamin Moore and Co. (Moore).
 - PPG Industries, Pittsburgh Paints (Pittsburgh).
 - Pratt and Lambert (P & L).
 - The Sherwin-Williams Company (S-W).

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS, EXCAVATION AND BACKFILL FOR DIV. 21 WORK:

Coordinate below with Architect for Division 02.

- A. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during excavation operations.
- B. Notify proper authorities prior to commencing excavation. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

Delete below if no existing utilities.

- C. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Architect/Engineer and then only after acceptable temporary utility services have been provided.
 - 1. Provide minimum of 48-hour notice to Architect/Engineer, and receive written notice to proceed before interrupting any utility.

Edit above to suit project requirements.

- D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.
- E. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights. Where trenches cross roads, walks, or public thoroughfares, provide suitable barricades and bridges adequately protected by signs or red flags during day and lights at night.
- F. Operate warning lights as recommended by authorities having jurisdiction.
- G. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
 - 1. Perform excavation within drip-line of large trees to remain by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.
- H. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install Fire Protection work on frozen excavation bases or subbases.

3.2 EXCAVATING FOR DIVISION 21 WORK:

- A. General: Do not excavate for Fire Protection work until work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum.
- B. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
- C. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- D. Deep Excavation Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
- E. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.
- F. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
- G. Dewatering: Lay no pipe in water. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
- H. Do not allow water to accumulate in excavations. Remove water to prevent soil changes detrimental to stability of subgrades. Provide and maintain pumps, well points, sumps,

suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

- I. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- J. Excavation for Pavements: Cut surface under pavements as required. Repave all streets or sidewalks disturbed at this Contractor's expense, to recommendations, procedures and satisfaction of the Architect/Engineer and authorities having jurisdiction.
- K. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe.
- L. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups. Any trenches dug below required depth shall be filled to proper depth with sand.
- M. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
- N. For pipes 5" or less in nominal size, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
- O. For pipes or conduit 6" or larger in nominal size, tanks and other Fire Protection work indicated to receive subbase, excavate to subbase depth indicated, or, if not otherwise indicated, to 6" below bottom of work to be supported.
- P. Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam, condensate, drainage) so top of piping is not less than 3'-6" below finished grade.

3.3 PREPARATION OF FOUNDATION FOR BURIED PIPING:

- A. Grade trench bottom to provide smooth, firm, stable, and rock-free foundation throughout length of piping.
- B. Remove unstable, soft, and unsuitable materials at surface on which piping is to be laid, and backfill with clean material as specified.
- C. Shape bottom of trench to fit bottom of piping. Fill unevenness with tamped-sand backfill. Dig bell holes at each pipe joint to relieve bells of loads and to ensure continuous bearing of pipe barrel on foundation.
- D. Care shall be exercised to keep interior of buried piping free of dirt and foreign matter.

3.4 BACKFILLING:

- A. Backfill with finely-graded subbase material to 6" above wrapped, coated, and plastic piping and tanks, and to centerline of other tanks.

- B. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.
- C. Backfill simultaneously on opposite sides of Fire Protection work, and compact simultaneously; do not dislocate work from installed positions.
- D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (% of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.
 - 1. Lawn and Landscaped Areas: 85% of cohesive soils; 90% for cohesionless soils.
 - 2. Paved Areas, Other Than Road ways: 90% for cohesive soils; 95% for cohesionless soils.
 - 3. Roadways: 90% for cohesive soils; 95% for cohesionless soils.
- E. Backfill to elevations matching adjacent grades, at time of backfilling excavations for Fire Protection work.

3.5 DISPOSAL OF EXCESS AND WASTE EXCAVATION MATERIALS:

- A. Removal from Owner's Property: Remove excess excavated material, trash, debris and waste materials and dispose of it off Owner's property.

3.6 INSTALLATION OF CONCRETE WORK

Coordinate concrete work in this section with Division 03 Section "Cast-In-Place Concrete" or "Miscellaneous Cast-In-Place Concrete."

Retain below when seismic restraints are required. Coordinate below with Division 21 Sections specifying equipment. Indicate dowel rod quantity, size, and spacing on drawings.

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions [**and according to seismic codes at Project**].
- B. Formwork:
 - 1. General: Design, construct and maintain formwork to support vertical and lateral loads including pressure of cast-in-place concrete. Construct formwork so that formed concrete will be required size and shape and in required location. Construct with joints which will not leak cement paste. Form sides and bottoms of concrete work, except where clearly indicated to be cast directly in excavation or against other construction, or on grade or prepared subgrade. Design and construct forms for easy removal without damage to concrete and other work.
 - a. Install chamfer strips at external corners of exposed concrete work.
 - b. Construct forms to retain equipment anchor bolts in accurate locations during placement of reinforcing steel and concrete. Use templates furnished by equipment

manufacturers to locate anchor bolts or, where not furnished, locate by accurate measure from certified setting diagrams.

C. Placing Reinforcement:

1. General: Comply with requirements and recommendations of specified standards, including "Placing Reinforcing Bars" by CRSI. Place bars where indicated and support to prevent displacement during concrete placement, using appropriate reinforcement supports, properly spaced and wire tied to reinforcing bars.
 - a. Place reinforcement to obtain at least minimum recommended coverages for concrete protection. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which would reduce bond with concrete.

D. Placing Concrete:

1. Wet wooden forms which have been coated with compound, immediately before concrete, and remove excess water from forms.
2. Strength-Class Application: Comply with the following general application requirements.
 - a. Backfill: Provide backfill class (lean concrete).
 - b. Underground Structural Concrete: Provide 3000 PSI class.
 - c. Block-Type Foundations: Where least dimension is not less than 0.2 x largest dimension, provide 3000 PSI class.
 - d. Beam-Type Foundations: Where least dimension is less than 0.2 x largest dimension, provide 4000 PSI class.
 - e. Miscellaneous Supported Work: Provide 3000 PSI class for curbs, pads, and similar supported work.
 - f. Concrete Fill: Provide 2500 PSI class for filling structural steel foundation frames and for filling similar large-volume units.
 - g. Concrete Grout: Provide rough grouting class for filling voids to be grouted which are too small to be filled effectively with 2500 PSI class concrete.
 - h. Patching General Concrete Work: Match concrete being patched.
3. Deposit concrete continuously or in layers of thickness which will result in no concrete being placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within section. If section cannot be placed continuously, provide construction joints. Deposit concrete as nearly as practicable in its final location, so as to avoid segregation due to rehandling or flowing.
4. Consolidate placed concrete by Fire Protection vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures complying with recommended practices of ACI 309; eliminate voids in work.
5. Cold Weather Placement: Comply with ACI 306. Do not use frozen materials or materials containing ice and snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. When air temperature has fallen or is expected to fall below 40 deg F (4.4 deg C), heat water and aggregates uniformly before mixing, as

required to obtain concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (26.7 deg C), at time of placement. Protect concrete work from physical damage and reduced strength resulting from frost, freezing actions, or low temperatures.

6. Finishing Horizontal Surfaces: Float and trowel horizontal (top) surfaces to level, smooth, uniform textured, dense finish, where surface is to remain exposed or receive coating, membrane or other thin-set finish. Otherwise, leave struck-off surface undisturbed; except scratch surfaces which are to receive concrete or mortar topping or setting bed, by raking with a stiff broom.
7. Depress top of concrete backfill sufficiently so that supported work can be set in bed of mortar or sand as indicated.
8. Curbs: Provide monolithic finish on interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to hard, dense finish with corners, intersections and terminations slightly rounded and coved.
9. Surface Repairs:
 - a. Unexposed Surfaces: Repair significantly damaged and honeycombed areas, and remove major projections and fins where forms have been removed.
 - b. Exposed Surfaces: On formed surfaces which are to be exposed, including those to be coated or covered with membrane or other thin-set applied finish, repair and patch form-tie holes and damaged and honeycombed areas, filling voids with grout and completely removing fins and other projections.

E. Concrete Curing and Protection;

1. General: Protect freshly placed concrete from drying and excessively cold and hot temperatures, and maintain in moist condition at relatively constant temperature for period of time necessary for hydration of cement, proper hardening, and achievement of strength requirements as specified.

F. Miscellaneous Concrete Work:

1. Concrete Grouting:
 - a. Mix and install grout for Fire Protection equipment base bearing surfaces, pump and other equipment base plates, and anchors.
 - b. Clean surfaces that will come into contact with grout.
 - c. Provide forms as required for placement of grout.
 - d. Avoid air entrapment during placement of grout.
 - e. Space approximately 1" thick between bottom of equipment and top of concrete foundation or base which remains after shimming, shall be filled completely with grouting. Grout shall be made up with sand and cement designed for the purpose which does not shrink on setting up.
 - f. Grout openings and recesses as indicated, in and around Fire Protection work and other work which penetrates or adjoins Fire Protection concrete work, using rough grouting class of concrete mix.
 - g. Provide formwork where required, and tamp, screed and trowel surfaces.
 - h. Place grout on concrete bases and provide smooth bearing surface for equipment.
 - i. Place grout around anchors.
 - j. Exposed surface of grouting shall be finished to make a neat appearance.

- k. Cure grout as specified for concrete work.
 - 2. Concrete Bases: In the absence of more specific information, either on drawings, or manufacturer's literature, the bases shall be level, shall have a minimum height above finished floor of 4" and extend 3" beyond the skids, feet or bed plate of the item of equipment.
 - 3. Concrete pads, beams, pedestals, or saddles placed in existing structures shall be mounted securely to the original substrate with anchor bolts.
- G. General Concrete Clean-Up: Upon completion of concrete work, clean excess concrete from adjacent areas and surfaces. Remove excess concrete by proper methods of washing or scraping, using care not to scratch or otherwise damage finished surfaces.

3.7 SURFACE PREPARATION FOR PAINTING:

- A. General: Clean surfaces before applying paint products. Remove oil and grease prior to mechanical cleaning. Comply with paint products manufacturer's instructions for surface cleaning and preparation. Remove surface-applied accessories which are not to be painted, and reinstall after completion of painting. Protect non-removable items not to be painted, by covering with paper or plastic film.
- B. Ferrous Metal Surfaces: Clean and remove mill scale and loose rust on surfaces which are not zinc-coated or shop/factory prime coated.
- C. Zinc-Coated Surfaces: Clean with non-petroleum based solvent. Wash with copper sulfate solution and flush with water, unless surface has been pretreated, or unless treatment is not recommended by manufacturer of prime coat.

3.8 PAINT SYSTEM APPLICATION:

- A. Environmental Conditions, Painting Work: Comply with governing regulations concerning use of and conditions for application of paint. Comply with manufacturer's recommendations and instructions. Do not apply paint in unfavorable conditions of temperature, moisture (including humidity) or ambient contamination (dust and other pollutants).
- B. Mixing: Comply with manufacturer's recommendations for mixing or stirring paint products immediately before application.
- C. Application Limitations: Except as otherwise indicated, paint every accessible surface of each unit of work indicated to be painted, regardless of whether in location recognized as "concealed" or "exposed".

Delete from and insert into the following list of omissions to satisfy project requirements.

- 1. Omit painting on surfaces located in service shafts and above non-removable ceilings and in similar places where in the opinion of the Engineer, space is too limited or services are too congested to allow access for painting.

2. Omit painting on machined sliding surfaces and rotating shafts of equipment, and on nonferrous finished metals including chrome plate, stainless steel, special anodized aluminum, brass/bronze and copper, and on plastics and similar finished materials, except where specifically indicated to be color-coded by painting.
 3. Omit painting on required name plates, labels, identification tags, signs, markers, printed instructions, performance ratings, flow diagrams and similar text and graphics, located within the scope of work indicated to receive paint application.
 4. Omit specified prime coat of paint system for metal surfaces where surface has shop-applied prime coat of equivalent quality. Apply prime coat on other surfaces to be painted; comply with paint manufacturer's instructions for prime coating where not otherwise indicated. Apply additional prime coats where suction spots or unsealed areas appear.
- D. General Application Requirements: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate, for type of material being applied, and for ambient conditions. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Apply paint at edges, corners, joints, welds and exposed fasteners in manner which will ensure dry-film thickness equal to that of flat surfaces. Allow sufficient time between successive coats for proper drying (comply with manufacturer's drying instructions).
1. Number of Coats: Number indicated is minimum number; apply as many coats as are necessary to comply with dry-film thickness requirements.
 2. Coating Thickness: Apply uniform coats to produce dry-film thickness indicated or, if not otherwise indicated, apply paint without thinning in application thickness recommended by manufacturer for each coat.
 3. Smooth Finishes: Except as otherwise indicated, apply paint in smooth finish without noticeable texture, cloudiness, spotting, holidays, laps, brush marks, runs, sags, ripples, ropiness and other surface imperfections.
 4. Textured Finishes: Where indicated, roll and redistribute paint of final coat to even texture. Match adjoining texture paint finishes if any, and roll to eliminate evidence of roller or lap marks and other unevenness and imperfections.

3.9 PAINTING CLEAN-UP AND PROTECTION:

- A. General Painting Clean-Up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day. When directed by Architect/Engineer, retain paint containers from application of coatings on particular unit or area of work, until average dry-film thickness has been calculated.

Delete below if final cleaning is not done by painter. This may be the general contractor's responsibility.

1. Spattered Surfaces: Upon completion of painting work, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.
2. Protection: Protect work of other trades, whether to be painted or not, against damage by painting work. Correct damage by cleaning, repairing or replacing and

repainting as directed. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings installed for protection of work not to be painted, after completion of painting operations. At completion of work by other trades, touch-up and restore damaged or defaced painted surfaces.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor Fire Protection materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

Retain below if relevant.

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor Fire Protection materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

Delete below when demolition and / or reference to Division 01 is not included in the project.

3.12 SELECTIVE DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching".
- B. Refer to Division 01 Specifications for outline of recycling and salvaging materials, procedures, and overall diversion goals for demolition.
- C. General: demolish, remove, demount, and disconnect abandoned Fire Protection materials and equipment indicated to be removed and not indicated to be salvaged or saved. Remove associated hangers, supports, miscellaneous steel. Disturbed remaining insulation to be repaired to match existing with vapor barrier.
- D. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
- E. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
- F. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- G. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

- H. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- I. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- J. Where walls are removed and sleeves are left on Fire Protection piping, remove the sleeves and associated insulation and install new insulation.
- K. Exposed piping indicated to be removed back to the active line and capped.
- L. Protect adjacent materials indicated to remain.
- M. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
- N. Locate, identify, and protect Fire Protection services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- O. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing Fire Protection materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for relocation or storage.
- P. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- Q. Fire Protection Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, supports, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.
 - a. Unless otherwise indicated, piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
 - 2. Perform cutting and patching required for demolition in accordance with requirements of other sections of this specification.
- R. The use of explosives in this work is prohibited.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

- B. Backfill and Fill Material: Backfill requirements at road and parking lot crossings shall meet the City of Kent's standards for backfilling. City of Kent's approval is not required unless work is within the public right of way or the utility is owned by the city. Review with OUA if any questions.
- C. Miscellaneous Metals: All outdoor miscellaneous metal equipment supports shall be galvanized steel. Spray-on galvanizing shall be applied to all disturbed areas. All indoor miscellaneous metal equipment supports shall be black iron, primed and painted or galvanized.
- D. All materials shall be non-asbestos containing.
- E. All firestop material shall be painted to match adjacent wall surfaces in visible public spaces.
- F. Obtain welding permit from KSU OUA.

END OF SECTION 210501

SECTION 210513 - COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings, and further described in other specification sections.

1.3 SUBMITTALS

- A. Submit product data for motors and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections. Submit compliance to referenced standards and efficiencies.
- B. Free standing motors and other electrical components not submitted under other sections shall require separate submittal.
- C. Submit manufacturer's electrical requirements for power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

1.4 QUALITY ASSURANCE

- A. National Electrical Manufacturer's Association (NEMA) Standards MG 1: Motors and Generators, "Energy Efficient Design".
- B. NEMA Standard 250: Enclosures for Electrical Equipment
- C. Comply with National Electrical Code (NFPA 70). Provide motors specified in this section that are "Listed and Labeled" as defined in Article 100.

1.5 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
1. Motor controllers.
 2. Torque, speed, and horsepower requirements of the load.
 3. Ratings and characteristics of supply circuit and required control sequence.
 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Baldor
 2. General Electric
 3. Lincoln
 4. Allis-Chalmers
 5. Reliance Electric
 6. WEG
- B. Comply with NEMA MG 1 unless otherwise indicated.

Retain option below for severe duty motors.

- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
1. Motors ½ HP and Larger: Polyphase.
 2. Motors Smaller than ½ HP: Single phase.
 3. Frequency Rating: 60 Hz.
 4. Voltage Rating: Determined by voltage of circuit to which motor is connected.
 5. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.
 6. Temperature Rise: Match insulation rating, unless otherwise indicated.
 7. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
 8. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

9. Enclosure Type: Shall be open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, guarded drip-proof motors where exposed to contact by employees or building occupants, and weather protected Type I for outdoor use, Type II where not housed.
10. Overload Protection: Built-in thermal overload protection rated at 115% of full load motor and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
11. Efficiency: Motors shall have a minimum efficiency as scheduled in accordance with NEMA Standard MG-1, most current table for high efficiency motors. Motors must meet or exceed the guaranteed minimum of this standard and shall be nameplated with the nominal value.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage, unless otherwise indicated.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating, unless otherwise indicated.
- I. Insulation: Class F.
- J. Code Letter Designation:
 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Provide with integral motor bearing current protection (AEGIS) rings.

Retain option below only if project requires severe duty motors based on environmental conditions

- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
- D. Source Quality Control: Perform the following routine tests according to NEMA MG 1:
1. Measurement of winding resistance.
 2. No-load readings of current and speed at rated voltage and frequency.
 3. Locked rotor current at rated frequency.
 4. High-potential test.
 5. Alignment.

2.5 SINGLE-PHASE MOTORS

- A. As indicated in equipment specification sections, or if not indicated as selected by manufacturer from one of the following to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split phase start, capacitor run.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Service Factor: 1.15.
- D. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading used on belt connected motors. Sealed, prelubricated sleeve bearings for other single-phase motors..
- E. Motors 1/20 HP and Smaller: Shaded-pole type.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range, unless otherwise noted.

PART 3 - EXECUTION (Not Applicable)

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 SHAFT GROUNDING RINGS (ALL MOTORS WITH VARIABLE FREQUENCY DRIVES)

- A. Shaft grounding rings (SGR) shall be factory installed inside the motors by the manufacturer wherever possible. SGR's may be field installed by installing contractor subject to Engineer's approval. Provide AEGIS SGR Colloidal Silver Shaft Coating, or approved equal, on shafts prior to rings installation, per SGR manufacturer's recommendations, after first cleaning shafts.
- B. Install and test SGR's in accordance with manufacturer's recommendations. Install the SGR so that the aluminum frame maintains an even clearance around the shaft. Conductive microfibers shall be in full circumferential contact with conductive metal surface of the shaft. Do not use thread lock to secure the mounting screws as it may compromise the conductive path to ground. If thread lock is required, use a small amount of EP2400 AEGIS Conductive Epoxy, or approved equal, to secure the screws in place.
- C. Shafts shall be clean and free of any coatings, paint, or other nonconductive material (clean to bare metal). Depending upon the condition of the shaft, it may require using emery cloth or Scotch-Brite. If the shaft is visibly clean, a non-petroleum based solvent may be used to remove any residue.
- D. Check the conductivity of the shaft using an ohm meter.
 - 1. Ohms test: Place the positive and negative meter leads on the shaft at a place where the microfibers will contact the shaft. Each motor will have a different reading but in general one should have a maximum reading of less than 2 ohms. If the reading is higher, clean the shaft again and retest.
- E. After motors with SGR are fully installed in the field (in equipment, assemblies, or individually), for both factory-installed-SGR and field-installed-SGR cases, test for a conductive path to ground using an Ohm meter.
 - 1. Place one probe on metal frame of SGR and one probe on motor frame.
 - 2. Motor must be grounded to common earth ground with variable frequency drive according to applicable standards.
 - 3. Verify that SGR installations and test readings comply with SGR manufacturer's requirements.
 - 4. Shaft voltage testing and verification of the proper installation of the AEGIS Bearing Protection Ring and its effectiveness can be accomplished by testing the motors for shaft voltages using a digital oscilloscope that is 100-Mhz or faster.
 - 5. An AEGIS Shaft Voltage Test Probe is attached to the oscilloscope probe end which is then placed on the machine's shaft allowing for the "real time" measurement of machines as they are operating under PWM IGBT VFD control.

4.2 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. PRODUCTS:
 - 1. All electrical components shall be UL labeled.
 - 2. Noise Rating: Motors shall be of "premium" efficiency and shall exceed mandated government efficiencies. All motors shall employ bearings for a "quiet" noise rating.
 - 3. Efficiency: "Energy Efficient" motors shall be of premium efficiency as scheduled in accordance with IEEE Standard 112, test method "B".
- C. INSTALLATION:
 - 1. All electrical installations shall comply with the Division 26 specifications and with the National Electric Code.

END OF SECTION 210513

KSU DESIGNERS NOTES:**1. Motors:**

- a. 1/3 HP and below use 120V/1 Phase/60Hz. (Unless reviewed with KSU/OUA)
- b. 1/2 HP and above use 208, 230 or 460V/3 Phase/60HZ. (Unless reviewed with KSU/OUA)
- c. Associate to provide info on efficiency and motor types, nameplate data to OUA for review.
- d. Harmonics and lubrication shall be addressed. Motor brake HP, RLA, LRA shall be indicated on the drawing schedules.
- e. All motors shall have a minimum service factor of 1.15 and be designed for non-overloading use.
- f. Motors exposed to wet locations shall be TEFC or meet NEC requirements, whichever is more stringent.
- g. "AEGIS" Type Shaft grounding technology shall be applied to all motors driven by VFDs. This applies to pumps, fans, and other systems on VFD driven type of systems. Review other system if base of design is not around AEGIS.

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.
5. Mechanical System Sound Stopping.
6. Mechanical System Penetration Seals.

- B. Related Requirements:

Leave Paragraph below if included in specifications

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 DESCRIPTION OF WORK

1. Furnish and install sound stopping around penetrations or mechanical materials and equipment.
2. Furnish and install fire and smoke penetration seals around penetrations of mechanical materials and equipment through fire or smoke barriers, floors and foundation walls.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Fire and Smoke Sealers: For each type of installation provide corresponding assembly detail complying with the current NFPA, ASTM E814, and by Underwriters Laboratory requirements.
- C. Mechanical System Penetration Seals (Firestopping): Submit the following:
 1. Shop drawings showing each condition requiring penetration seals in dictating proposed UL systems materials, anchorage, methods of installation, and actual adjacent construction.

2. A copy of UL illustration of each proposed system indicating manufacturer approved modifications.
3. Manufacturer's specifications, recommendations, installation instructions and maintenance instructions.
4. Tested firestop systems engineering judgement.

1.5 QUALITY ASSURANCE

- A. The firestopping systems are to be installed by experienced, manufacturer trained, and UL certified or FM certified personnel.
- B. All firestopping material is to be provided from a single manufacturer for all applications.
- C. Consult manufacturer's technical experts for assistance in selective appropriate firestop system for each application.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- D. Molded non-conductive, high impact resistant HDPE sleeves (for installations less than 150°F) similar to Proline CS – Century Line Sleeve or Westlantic Tech Corp Wall Sleeves WA. Provide with puddle flange (water stop ring) configuration for mechanical sleeve seal installations.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Flexicraft.
 4. Link-Seal / Thunderline Corp. / Garlock Piping Technology.
 5. Metraflex Company (The).
- B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
3. Sealing Elements: EPDM-rubber for systems up to 250°F interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size. Pressure plates to be composite plastic.
4. Sealing Elements: High-temperature-silicone for systems up to 400°F with interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size. Pressure plates to be coated carbon steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
6. Concrete Wall Penetrations: All concrete wall penetration sleeves shall have a puddle flange (water stop ring) configuration.

2.3 GROUT

- A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, mildew resistant, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer.
- B. Install sleeves accurately centered on pipe runs.
- C. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but no less than 2 pipe sizes larger than piping run.
- D. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for insulation installation.

- E. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 2" above level floor finish, 3/4" above floor finish sloped to drain, and flush with floor in other areas.
- F. Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves.
- G. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- H. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

Retain below if sleeves are not required for core-drilled holes.

- 1. Sleeves are not required for core-drilled holes.
- I. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

Retain below if sleeves are not required for holes in slabs formed by PE or PP molded sleeves.

- 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
- 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
- 3. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.

Delete references to Division 07 if not applicable.

- J. Install sleeves for pipes passing through interior partitions and slabs as they are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
 - 4. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - 5. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - 6. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - a. **Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.**
 - b. Seal space outside of sleeve fittings with grout.
 - 7. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.
 - a. **Refer to Division 07 Section "Joint Sealants" for materials and installation.**

- K. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- L. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- M. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

I. Refer to Division 07 Section "Penetration Firestopping" for materials.

- N. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials.

Leave Paragraph below if included in specifications

1. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron sleeves.
 - b. Piping NPS 6 and Larger: Cast-iron pipe sleeves.
2. Exterior Concrete Walls Below Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs Above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Steel pipe sleeves.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

3.5 FIRE PROTECTION SYSTEM SOUND STOPPING

- A. Where pipes or ducts or other components of Division 21 work pass through non-fire rated walls or floors, but walls which extend from horizontal structure to structure, provide sound stopping between such mechanical work and the building structure intended to reduce the transmission of sound from one side of the wall to the other.
- B. Sound stopping of pipes in sleeves shall consist of sealing the outside of the sleeve with caulking and the inside with an insulating material.
- C. Sound stopping of pipes or ducts without sleeves shall consist of packing the cavity around the penetration with an insulating material and sealing the opening with approved sealant or plaster.
- D. Insulating materials shall be non-asbestos and non-friable, and shall have a flame spread rating of no more than 25 and a smoke developed rating of no more than 50.

3.6 FIRE PROTECTION SYSTEM PENETRATION SEALS

- A. Where pipes or ducts or other components of Division 21 work pass through fire or smoke rated walls or floors, provide non-asbestos seal assemblies classified by UL to provide fire barriers equal to the time rating of the construction being penetrated, with materials that comply with applicable codes and that have been tested in accordance with UL 1479 or ASTM E-814.
- B. Install penetration seal materials in accordance with printed instructions of the UL Building Materials Directory and in accordance with manufacturer's instructions. Seal all holes or voids made by penetrations. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor.
- C. The contractor shall provide submittal data on each installation type for approval by the Associate.
- D. Fire and smoke sealing systems shall be tested in accordance with the appropriate current NFPA ASTM E 814 and by Underwriters Laboratories requirements.
- E. All materials shall be non-asbestos containing.
- F. All firestop material shall be painted to match adjacent wall surfaces in visible public spaces.
- G. Hold a pre-installation meeting with General associated trades and Owner. Review contractor inspection guidelines.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

- B. Standard sealant manufacturer colors shall be submitted to the Associate for selection, and to KSU OUA for approval. Sealant to be non-asbestos containing.
- C. All firestop material shall be painted to match adjacent wall surfaces in visible public spaces.

END OF SECTION 210517

SECTION 210518 - ESCUTCHEONS FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Escutcheons.
- 2. Floor plates.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel or brass with polished, chrome-plated finish and spring-clip fasteners.
- D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall:
 - 1) One-piece, deep pattern with spring-clip fasteners.
 - b. Chrome-Plated Piping:
 - 1) One-piece cast brass.
 - c. Insulated Piping:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - f. Bare Piping in Unfinished Service Spaces:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - g. Bare Piping in Equipment Rooms:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - 2. Escutcheons for Existing Piping to be split-plate, stamped steel with concealed hinge for the following:
 - a. Chrome-Plated Piping.
 - b. Insulated Piping.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces.
 - e. Bare Piping in Unfinished Service Spaces.
 - f. Bare Piping in Equipment Rooms.
 - 3. Escutcheon Finishes:
 - a. Furnish pipe escutcheons with chrome finish for occupied areas, prime paint finish for unoccupied areas.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with inside diameter to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 SUPPLEMENTAL REQUIREMENTS

- A. General: Provide pipe escutcheons on all pipes passing through floors and all pipes passing through walls or ceilings in exposed areas with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with chrome finish for occupied areas, prime paint finish for unoccupied areas.
- B. Pipe Escutcheons for Moist Areas including Equipment Rooms: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
- C. Pipe Escutcheons for Dry Areas: Provide chrome plated sheet steel escutcheons, solid or split hinged.
- D. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole and is flush with adjoining surface.

END OF SECTION 210518

KSU DESIGNERS NOTES:

1. Coordinate finished with KSU and Architect. Specification as is requires all exposed penetrations in occupied areas to be chrome plated and prime paint finish for unoccupied areas.

SECTION 210519 - METERS AND GAGES FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Dial-type pressure gages.
 - 2. Gage attachments.
- B. Related Requirements:

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 DIAL-TYPE PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - 1. Standard: ASME B40.100.

2. Case: Liquid-filled drawn steel on all vibrating equipment; minimum 4-1/2" diameter above 6'-0" above floor, 3-1/2" below 6'-0" above floor.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Plastic.
9. Ring: Stainless steel.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.2 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- B. Install valve and snubber in piping for each pressure gage for fluids.
- C. Install pressure gages in the following locations:
 1. Inlet and discharge of each pressure-reducing valve.
 2. Suction and discharge of each pump.

3.2 CONNECTIONS

- A. Install gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of gages to proper angle for best visibility.

3.4 PRESSURE-GAGE SCHEDULE

- A. Gages installed with improper ranges will be required to be replaced by the contractor at no additional costs after system commissioning is complete.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Fire Suppression-Water Piping:
 - 1. 0 to 160 psi.

PART 4 - SUPPLEMENTAL REQUIREMENTS:

4.1 PRESSURE GAUGE INSTALLATION

- A. All gauges to be rated for fluid applications with expected operating pressure to fall in the middle of the pressure range
- B. Gauges shall include isolation ball or gate valve (steam), schedule 80 nipples, fittings and pipe. Provide tee fitting between isolation valve and gauge.
- C. Pressure gauges shall be located in the following locations (minimum):
 - 1. Suction and discharge of pumps.
 - 2. Fire protection systems including limited area systems connected to potable water.
 - 3. Upstream and downstream of main building backflow devices, i.e. fire system double check and domestic water RBPB (RPZ).

4.2 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Mercury type thermometers are not permitted.
- C. All gauges to be rated for fluid applications with expected operating pressure to fall in the middle of the pressure range. Select range for various utilities above.

END OF SECTION 210519

KSU DESIGNERS NOTES:

- 1. **Dial thermometers minimum 4½" diameter will be acceptable in certain fluid applications. Consult with OUA.**

SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.
8. Roof equipment supports.

B. Related Requirements:

Retain only relevant sections below.

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 210516 "Expansion Fittings and Loops for Fire Suppression Piping" for pipe guides and anchors.
3. [Section 210548 "Vibration and Seismic Controls for Fire Suppression Piping"]
[Section 210548.13 "Vibration Controls for Fire Suppression Piping"] for vibration isolation devices.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support. For equipment curbs supply manufacturer's certified load bearing data.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support, indicating dimensions, weights, required clearances, and methods of assembly of components.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.
- C. Codes and Standards:
 - 1. Code Compliance: Unless requirements are exceeded herein, comply with applicable codes pertaining to product materials and installation of supports and anchors. For Ohio projects, follow the State Architect's "Handbook of Instruction" and Ohio Basic Building Code for maximum hanger spacing requirements.
 - 2. Comply with NFPA 13 for hangers and supports used as components of fire protection systems. Include listing and labeling by UL and FM.

PART 2 - PRODUCTS

2.1 MANUFACTURERS OF HANGERS AND SUPPORTS:

- A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - 1. B-Line Systems, Inc.
 - 2. Globe Hanger
 - 3. ITT Grinnell Corp.
 - 4. Michigan Hanger
 - 5. Modern Hanger
 - 6. nVent Caddy
 - 7. PHD Manufacturing, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for Fire Suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

Retain below if seismic restraints are required.

- 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.3 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper, factory-fabricated components or nylon. Plated copper is not acceptable.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel or stainless steel.

2.4 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
- B. Cushion Clamps: UL Classified 2043 (25/50), Molded with high strength Thermoplastic Elastomer (TPE). Temperature rating: -65°F to 275°F. Clamps to be by Hydra-Zorb.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psi or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with 100-psi ASTM C 552, Type II cellular glass with 100-psi minimum compressive strength.
- C. Insulation-Pipe Supports for Cold or Hot Piping: Where insulated piping is supported from unistrut or other similar systems, crush resistant insulation clamps similar to ZSI Cush-A-Therm, K-Flex® 360 Insulated Pipe Support, and Klo-Shure insulation couplings will be acceptable.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Indoor Applications: Zinc-coated or stainless-steel.
 - 2. Outdoor Applications: Stainless steel.

2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
 - 1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Hardware: Galvanized steel or polycarbonate.
 - 4. Accessories: Protection pads.
- C. Low-Profile, Single Base, Single-Pipe Stand:

Engineer to provide detail of assembly including pipe support types and heights.

- 1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Vertical Members: Two, galvanized (indoor applications) or stainless-steel (outdoor applications), continuous-thread 1/2-inch rods.
 - 4. Horizontal Member: Adjustable horizontal, galvanized (indoor applications) or stainless-steel (outdoor applications) pipe support channels.
 - 5. Pipe Supports: Roller, Strut clamps, Clevis hanger, or Swivel hanger as detailed on drawings.
 - 6. Hardware: Galvanized (indoor applications) or Stainless steel (outdoor applications).
 - 7. Accessories: Protection pads.
 - 8. Height: See details on drawings.
- D. High-Profile, Single Base, Single-Pipe Stand:

Engineer to provide detail of assembly including pipe support types and heights.

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.
3. Vertical Members: Two, galvanized (indoor applications) or stainless-steel (outdoor applications), continuous-thread 1/2-inch rods.
4. Horizontal Member: One, adjustable height, galvanized (indoor applications) or stainless-steel (outdoor applications) pipe support slotted channel or plate.
5. Pipe Supports: Roller or Clevis hanger as detailed on drawings.
6. Hardware: Galvanized (indoor applications) or stainless steel (outdoor applications).
7. Accessories: Protection pads, 1/2-inch continuous-thread galvanized-steel rod (indoor applications) , 1/2-inch continuous-thread stainless-steel rod (outdoor applications).
8. Height: See details on drawings.

E. High-Profile, Multiple-Pipe Stand:**Engineer to provide detail of assembly including pipe support types and heights.**

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; vulcanized rubber or molded polypropylene.
3. Vertical Members: Two or more, galvanized (indoor applications) or stainless-steel (outdoor applications) channels.
4. Horizontal Members: One or more, adjustable height, galvanized (indoor applications) stainless-steel (outdoor applications) pipe support.
5. Pipe Supports: Roller, Strut clamps, Clevis hanger, Swivel hanger as detailed on drawings.
6. Hardware: Galvanized (indoor applications) or Stainless steel (outdoor applications).
7. Accessories: Protection pads, 1/2-inch continuous-thread rod.
8. Height: See details on drawings.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.**2.8 EQUIPMENT SUPPORTS**

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 ROOF EQUIPMENT SUPPORTS**SPECIFIER NOTE: COORDINATE TYPE OF ROOF EQUIPMENT SUPPORTS USED WITH ROOF CONSTRUCTION. VERIFY WHO FURNISHES AND WHO INSTALLS ROOF EQUIPMENT SUPPORTS WITH ARCHITECT.**

- A. Refer to the drawings, schedules and applicable specification sections for roof equipment supports indicated to be furnished by the unit manufacturer.

SPECIFIER NOTE: DELETE ABOVE, BELOW OR BOTH (IF ROOF EQUIPMENT SUPPORTS ARE SPECIFIED IN DIVISION 7) TO SUIT PROJECT REQUIREMENTS.

B. Fabricated Roof Equipment Supports:

1. General: Construct roof equipment supports using minimum 18-ga galvanized steel with fully mitered and welded corners, 3" cant, internal bulkhead reinforcing, integral base plates, pressure treated wood nailer, and 18-ga galvanized steel counterflashing.
2. Configuration: Construct of sizes as indicated, compensate for slope in roof so top of support is dead level.
3. Pipe Boots: Provide boots for piping, power conduit and control conduit as required by pipe curb manufacturer. Boot to be expandable, designed to accommodate the pipe or conduit size utilized, and capable of maintaining a weather-tight seal even with minor vibration in piping.
4. Manufacturer: Subject to compliance with requirements, provide roof equipment supports of one of the following:
 - a. Custom Curb
 - b. Pate Co.
 - c. Roof Products and Systems (RPS)
 - d. Thycurb Division; Thybar Corp.

2.10 MATERIALS

- A. Aluminum: ASTM B 221.
- B. Carbon Steel: ASTM A 1011/A 1011M.
- C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; galvanized.
- D. Stainless Steel: ASTM A 240/A 240M.
- E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- F. Metal Framing: NEMA STD ML 1.
- G. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards. Material coatings for interior use shall be electro-plated zinc (ASTM B633), or mill galvanized (ASTM A525 G90). For exterior use, materials shall be hot-dip galvanized after fabrication (ASTM A386).
- H. Bolts and Nuts: ASME B18.10 or ASTM A183, steel, hex-head, track bolts and nuts. Use galvanized or stainless steel for use in moist environments.
- I. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Non-staining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

3.2 INSPECTION:

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.3 PREPARATION:

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washer and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire protection piping independently of other piping.
- D. Prevent electrolysis in support of copper tubing by use of copper or nylon clamps and supports which are copper or stainless steel, or by other recognized industry methods. Copper-plated clamps in direct contact with copper piping is not acceptable.
- E. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- F. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- G. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- H. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- I. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- J. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
- Retain below if section 077200 is included in specifications.**
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- Q. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

3.5 EQUIPMENT SUPPORTS

- A. Provide painted structural steel stands to support equipment from structure overhead or to support equipment above floor.
- B. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.
- C. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- D. Provide lateral bracing, to prevent swaying, for equipment supports.

3.6 ROOF EQUIPMENT SUPPORTS:

Select one of the two paragraphs below. First paragraph is for projects where equipment supports are installed by division 07 work. Second paragraph is when provided and installed by this contractor.

- A. Furnish roof equipment supports to Contractor for installation as part of work of Division 7; not work of this section.
- B. Install roof equipment supports in compliance with manufacturer's instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive accessory units, vapor barriers, roof insulation, roofing and flashing as required to ensure that each element of the work performs properly and that combined elements are waterproof and weathertight. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures. Meet all requirements necessary to maintain the roofing manufacturer's warranty as applicable.

3.7 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.8 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.9 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 210501 Basic Materials and Methods for Fire Suppression for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.10 HANGER AND SUPPORT SCHEDULE

- A. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- C. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- D. Use stainless-steel pipe hangers and stainless-steel attachments for outdoor and hostile environment applications.
- E. Use copper or nylon pipe clamps and copper or stainless-steel attachments for copper piping and tubing.
- F. Use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with

MSS SP-69 and manufacturer's published product information. Use only one type of one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Copper-plated clamps are not acceptable for copper-piping systems. Clamps in direct contact of copper piping to be copper or nylon. Provide felt lined hangers or clamps for uninsulated refrigerant piping to eliminate transmission of sound and vibration. Perforated strap hangers shall not be used in any work. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 4. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 5. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 8. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
- I. Vertical-Piping Clamps: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with MSS SSP-58, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Copper-plated clamps are not acceptable for copper-piping systems. Clamps in direct contact of copper piping to be copper or nylon. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, expansion shells, inserts or beam clamps selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information.
1. All beam clamps shall be installed with a retaining strap to grasp two opposing sides of structure to prevent possible movement of the clamp due to vibration.
 2. Select size of building attachments to suit hanger rods.
 3. Provide copper-plated building attachments for copper-piping systems.
 4. "C" clamps shall not be permitted except on fire protection piping.
 5. Install building attachments at required locations within concrete or on structural steel for proper piping support.
 6. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - b. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 - c. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - d. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - e. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - f. C-Clamps (MSS Type 23): For structural shapes.
 - g. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - h. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - i. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 - j. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 - k. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 - l. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - 1) Light (MSS Type 31): 750 lb.
 - 2) Medium (MSS Type 32): 1500 lb.
 - 3) Heavy (MSS Type 33): 3000 lb.
 - m. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - n. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 - o. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- p. Space attachments within maximum piping span length indicated below. Install additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. For new concrete, install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

- 1) Two or one-end threaded rod sizing for various support loads shall be as follows:

ROD DIAMETER MAXIMUM LOAD (LBS.)

3/8"	610
1/2"	1130
5/8"	1810
3/4"	2710
7/8"	3770
1"	4960
1-1/8"	6230
1-1/4"	8000
1-1/2"	11630
1-3/4"	15700
2"	20700
2-1/4"	27200
2-1/2"	33500

Note limitations on structure supporting rods.

- 2) For reference purposes, the following table provides filled weights of steel piping for various sizes:

PIPE SIZE FILLED PIPE WEIGHT (LB/FT)

1/2"	1.0
3/4"	1.4
1"	2.1
1-1/4"	3.0
1-1/2"	3.6
2"	5.1
2-1/2"	7.9
3"	10.8
4"	16.3
6"	31.5
8"	50.2
10"	74.6
12"	98.6
14"	114.4
16"	141.8
18"	171.9
20"	204.4
22"	240.4
24"	278.7
26"	319.8

28"	363.6
30"	410.1
32"	459.3
34"	511.3
36"	565.9

- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- P. Piping support spacing:
1. All piping shall be supported at distances not exceeding the spacing in the following table. This table is intended for general distribution piping. Within equipment rooms, hangers must be arranged to provide full support of piping. No piping is to be supported by, or impose a load upon the equipment to which it is connected.
 2. Install hangers for steel piping with the following maximum spacing and minimum rod sizes unless hanger spacing is:
 - a. Specifically indicated on drawings
 - b. Indicated in other Division 21 specification sections for special applications
 - c. Required to be more frequently by State or local codes
 3. Maximum steel piping hanger supports
 - a. NPS 3/4: Maximum span, 7 feet.
 - b. NPS 1: Maximum span, 7 feet.
 - c. NPS 1-1/2: Maximum span, 9 feet.
 - d. NPS 2: Maximum span, 10 feet.
 - e. NPS 2-1/2: Maximum span, 11 feet.
 - f. NPS 3 and Larger: Maximum span, 12 feet.
 4. Maximum drawn-temper copper piping hanger supports:
 - a. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - b. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - c. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.

- d. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - e. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - f. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - g. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- R. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- S. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- T. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
- U. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- V. Horizontal Piping: Comply with the following installation requirements.
- 1. Individual hangers for uninsulated piping not specified to be supported with roller hangers may be supported with either adjustable band hangers or adjustable steel clevis hangers.
 - 2. Individual hangers for insulated piping not specified to be supported with roller hangers shall be adjustable steel clevis hangers.
- W. Heavy duty trapezes may be utilized for multiple horizontal pipes where applicable. Design of same shall be by trapeze manufacturer considering weight, available structure, pipe medium, material, etc. Supports for individual piping group on trapezes shall be as specified for individual piping.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Hangers in contact with copper pipe shall be copper or nylon. Plated copper not acceptable.
- C. All outdoor miscellaneous metal equipment supports not indicated to be stainless steel construction shall be galvanized steel. Spray-on galvanizing shall be applied to all disturbed areas. All indoor miscellaneous metal equipment supports shall be black iron, primed and painted or galvanized.

END OF SECTION 210529

SECTION 210553 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.
4. Underground-type plastic line markers.
5. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 8. Fasteners: Stainless-steel rivets or self-tapping screws.
 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: Size letters according to ASME A13.1 for piping. Abbreviate only as necessary for each application length.

2.3 VALVE TAGS

- A. Description: 1-1/2" diameter stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. Numbers to be sequenced. The tag engraving shall be filled with black enamel.
 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Tag Material: Plastic, 3/32-inch minimum thickness engraved plastic laminate valve tags and having predrilled or stamped holes for attachment hardware.
 3. Fasteners: Brass wire-link chain, brass or stainless steel beaded chain, or S-hook.

- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system service, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), equipment or area isolated, and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.
2. For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with plastic (plexiglass) panel. Submit valve schedule for Engineer's review prior to mounting.

C. UNDERGROUND-TYPE PLASTIC LINE MARKERS:

1. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
2. Provide multi-ply tape consisting of solid aluminum foil core between 2 layers of plastic tape.

2.4 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature:
 - a. Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE".
 - b. For confined space identification: "Danger" with the words "Permit-Required Confined Space. Do Not Enter".
 4. Furnish a quantity of 24 lockout tags, professionally pre-printed with the word "Danger" in white lettering on red background with the words "Do Not Start. Equipment Locked Out" following.
 5. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Equipment labels shall be located where accessible and easily seen from the front of the equipment. When the equipment itself is not able to accept the label (i.e. pressure sensitive tape does not stick to the surface) the tag shall be mounted in an appropriate location on the wall. Equipment tags shall include such information as make, model, capacity, voltage, static pressure ratings, CFM, GPM, TDH, HP, Building Automation System (BAS) tag number and pressure settings based on actual system setup at time of commissioning.
- C. At Installer's option, where equipment to be identified is concealed above acoustical ceiling or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).
- D. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.
- E. Provide labels for the following general categories of equipment and operational devices:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Meters, gages, thermometers and similar units.
- F. Equipment located concealed above ceilings or access doors shall be labeled utilizing an engraved tag or printed label, black 18-point size letters, on white background, mounted on the ceiling grid or on the access door.

3.4 CONFINED SPACE IDENTIFICATION:

- A. Furnish and install confined space identification signs in a conspicuous location where approved by Owner's authorized representative for each permit required confined space. A permit required confined space is defined as a confined space in which an employee's whole body can enter, has an entrance into or exit from the space which is restricted in any way, and is not designed for continuous employee occupancy. In addition, a permit required confined space must have the potential to contain a hazardous atmosphere, contain a material such as fluid or particles that could trap or asphyxiate an entrant, or contain any other serious safety or health hazard, such as an electrical or mechanical hazard. Examples of permit required confined

spaces requiring signs are air handling units, boilers, cooling tower sumps, underground tanks, vaults or manholes, etc.

3.5 LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Locate labels near points where pipes enter into and exit from concealed spaces (fixed ceiling, shaft, underground, or similar concealment) and at maximum intervals of 50 feet in each space where pipes are exposed or concealed by removable ceiling system. Reduce intervals to 25 feet in areas of congested piping and equipment. Label piping at both sides of wall or floor penetrations.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
 8. Main isolation valves located concealed above ceilings or access doors shall be labeled utilizing an engraved tag or printed label, black 18-point size letters, on white background, mounted on the ceiling grid or on the access door.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
1. Fire Protection Water: White letters on a safety-red background.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve tags shall include an abbreviation for the type of service.
 - a. Fire Protection Systems: LSP=Limited sprinkler, Fire Line, Dry Pipe Sprinkler, Wet Pipe Sprinkler.
 2. Valve-Tag Colors:

- a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
- b. Flammable Fluids: Black letters on a safety-yellow background.
- c. Combustible Fluids: White letters on a safety-brown background.
- d. Potable and Other Water: White letters on a safety-green background.
- e. Compressed Air: White letters on a safety-blue background.

C. UNDERGROUND PIPING IDENTIFICATION:

1. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Kent State University Requirements
 1. Identification shall comply with ANSI A13.1 for lettering size, length of color field, colors and viewing angles of identification.
 2. Coordinate exposed labels on ceiling grids, access doors, etc. with KSU OUA prior to installation.
 3. Valve Chart: A typewritten directory of all valves shall be framed under glass and wall mounted. Coordinate location with KSU OUA. The valve list shall include the valve number, type of service, size, approximate location, and equipment or area isolated. A copy of the valve chart shall be included in the O&M manual.
 4. Flow arrows shall be reviewed by Associate prior to installation to verify proper direction and application.
 5. Pipe labels and equipment tags to be coordinated with OUA and A/E team. Colors to be as developed and specified by OUA.
 6. Painted stencils will be acceptable for duct labels in lieu of types specified above.

END OF SECTION 210553

KSU DESIGNERS NOTES:

1. Color and system coordinated with OUA and A/E team.

SECTION 211100 - FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes fire-suppression water-service piping and related components outside the building and service entrance piping into the building and the following:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-suppression specialty valves.
 - 3. Alarm devices.
- B. Utility-furnished products include water meters that are furnished to the site, ready for installation.
- C. Related Requirements:
 - 1. Section 211116 "Facility Fire Hydrants" for AWWA and UL-listed, dry- and wet-barrel fire hydrants.
 - 2. Section 211119 "Fire-Department Connections" for exposed-, flush-, and yard-type, fire-department connections.
 - 3. Section 211200 "Fire-Suppression Standpipes" for fire-suppression standpipes inside the building.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

- B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying the water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. Comply with FM Global's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

- E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

- F. Protect flanges, fittings, and specialties from moisture and dirt.

- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Suppression Water-Service Piping: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
- B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
- C. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- D. Copper, Pressure-Seal Fittings:
 - 1. Standard: UL 213.
 - 2. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - 3. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- F. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
- B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.
- C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end.
- D. Grooved-End, Ductile-Iron Pipe Appurtenances:
 - 1. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.

2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
 - E. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
 - F. Push-on-Joint, Ductile-Iron Fittings: AWWA C153, ductile-iron compact pattern.
 1. Gaskets: AWWA C111, rubber.
 - G. Flanges: ASME B16.1, Class 125, cast iron.
- 2.3 PE PIPE AND FITTINGS
- A. PE, Fire-Service Pipe: FM Global approved, with minimum thickness equivalent to Class 150.
 - B. Molded PE Fittings: FM Global approved; PE butt-fusion type, made to match PE pipe dimensions and class.
- 2.4 PVC PIPE AND FITTINGS
- A. PVC Pipe: AWWA C900 or UL 1285, Class 150, with bell end with gasket, and with spigot end.
 - B. PVC Fittings: AWWA C900 or UL 1285, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
- 2.5 SPECIAL PIPE FITTINGS
- A. Ductile-Iron Flexible Expansion Joints:
 1. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 2. Pressure Rating: 250 psig minimum.
 - B. Ductile-Iron Deflection Fittings:
 1. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 2. Pressure Rating: 250 psig minimum.

2.6 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Material: Linear low-density PE film of 0.008-inch minimum thickness.
- C. Form: tube.
- D. Color: Black.

2.7 JOINING MATERIALS

- A. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.
- C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.8 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
 - 1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners, and with ends of same sizes as piping to be joined.
 - 2. Standard: AWWA C219.
 - 3. Center-Sleeve Material: Manufacturer's standard.
 - 4. Gasket Material: Natural or synthetic rubber.
 - 5. Pressure Rating: 150 psig minimum.
 - 6. Metal Component Finish: Corrosion-resistant coating or material.

2.9 CORPORATION VALVES

- A. Corporation Valves: Comply with AWWA C800. Include saddle and valve compatible with tapping machine and manifold.
 - 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
 - 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
 - 3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
- B. Meter Valves: Comply with AWWA C800 for high-pressure, service-line valves. Include angle- or straight-through-pattern bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

2.10 CURB VALVES

- A. Curb Valves: Comply with AWWA C800 for high-pressure, service-line valves. Valve has bronze body, ground-key plug or ball, wide tee head, and inlet and outlet matching service piping material.
- B. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "FIRE WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
 - 1. Shutoff Rods: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.
- C. Meter Valves: Comply with AWWA C800 for high-pressure, service-line valves. Include angle- or straight-through-pattern bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

2.11 DETECTOR CHECK VALVES

- A. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
- B. Standards: UL 312 and FM Global's "Approval Guide."
- C. Pressure Rating: 175 psig.
- D. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

2.12 WATER METERS

- A. Water meters are furnished by utility company. (City of Kent – Neptune, 2-inch and smaller) (All other cities – in accordance with each water utility requirements.)
- B. Displacement-Type Water Meters:
 - 1. Description: With bronze main case.
 - 2. Standard: AWWA C700.
 - 3. Registration: Flow in gallons.
- C. Turbine-Type Water Meters:
 - 1. Standard: AWWA C701.
 - 2. Registration: Flow in gallons.
- D. Compound-Type Water Meters:

1. Standard: AWWA C702.
2. Registration: Flow in gallons.

E. Remote Registration System:

1. Description: Utility company's standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
2. Standard: AWWA C706.
3. Registration: Flow in gallons.

2.13 DETECTOR-TYPE WATER METERS

A. AWWA, Detector Check Water Meters:

1. Description: Main line, turbine meter with second meter on bypass.
2. Standard: AWWA C703.
3. Registration: Flow in gallons.
4. Pressure Rating: 150 psig.
5. Bypass Meter: AWWA C701, turbine-type, bronze case.
 - a. Size: At least one-half nominal size of main-line meter.

B. Fire-Protection, Detector Check Water Meters:

1. Description: Main-line turbine meter with strainer and second meter on bypass.
2. Standards: UL's "Fire Protection Equipment Directory" listing and FM Global's "Approval Guide."
3. Registration: Flow in gallons.
4. Pressure Rating: 175 psig minimum.
5. Bypass Meter: AWWA C701, turbine-type, bronze case.
 - a. Size: At least NPS 2.

C. Remote Registration System:

1. Description: Utility company's standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
2. Standard: AWWA C706.
3. Registration: Flow in gallons.

2.14 BACKFLOW PREVENTERS

A. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015 or AWWA C510.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: 5 psig maximum, through middle one-third of flow range.

4. Body Material: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved stainless steel for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight through flow.
7. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

B. Double-Check, Detector-Assembly Backflow Preventers:

1. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 5 psig maximum, through middle one-third of flow range.
4. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved Stainless steel.
5. End Connections: Flanged.
6. Configuration: Designed for horizontal, straight through flow.
7. Accessories:
 - a. Valves: UL 262 and FM Global's "Approval Guide" listing; OS&Y gate type with flanged ends on inlet and outlet.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

C. Backflow Preventer Test Kits:

1. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.15 ALARM DEVICES

- A. General: UL 753 and FM Global's "Approval Guide" listing, of types and sizes to mate and match piping and equipment.
- B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psig working pressure; designed for horizontal or vertical installation; with two single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.
- C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.
- D. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with water utility company for tap of size and in location indicated in water main.
- B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- C. Make connections larger than NPS 2 with tapping machine according to the following:
 - 1. Install tapping sleeve and tapping valve according to MSS SP-60.
 - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 - 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
 - 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- D. Make connections NPS 2 and smaller with drilling machine according to the following:
 - 1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company's standards.
 - 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
 - 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
 - 4. Install corporation valves into service-saddle assemblies.
 - 5. Install manifold for multiple taps in water main.
 - 6. Install curb valve in water-service piping with head pointing up and with service box.
- E. Comply with NFPA 24 for fire-service-main piping materials and installation.
- F. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
 - 1. Install encasement for tubing according to ASTM A 674 or AWWA C105.
- G. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
 - 1. Install encasement for piping according to ASTM A 674 or AWWA C105.
- H. Install PE pipe according to ASTM D 2774 and ASTM F 645.
- I. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

- J. Bury piping with depth of cover over top at least 30 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:
 - 1. Under Driveways: With at least 36 inches of cover over top.
 - 2. In Loose Gravelly Soil and Rock: With at least 12 inches of additional cover.
- K. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- L. Extend fire-suppression water-service piping and connect to water-supply source and building fire-suppression water-service piping systems at locations and pipe sizes indicated.
 - 1. Terminate fire-suppression water-service piping within the building at the floor slab or wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire-suppression water-service piping systems when those systems are installed.
- M. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- N. Comply with requirements for fire-suppression water-service piping inside the building in the following Sections:
 - 1. Section 211200 "Fire-Suppression Standpipes"
 - 2. Section 211313 "Wet-Pipe Sprinkler Systems"
 - 3. Section 211316 "Dry-Pipe Sprinkler Systems"
- O. Comply with requirements in Section 221116 "Domestic Water Piping" for potable-water piping inside the building.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in tubing NPS 2 and smaller.
- C. Install flanges, flange adaptors, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of tubes and remove burrs.

- E. Remove scale, slag, dirt, and debris from outside and inside of pipes, tubes, and fittings before assembly.
- F. Copper-Tubing, Braze Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- G. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
- H. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
- I. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts.
- J. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with bolts according to ASME B31.9.
- K. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
- L. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139.
- M. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.
- N. Do not use flanges or unions for underground piping.

3.4 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Heat-fused joints.
 - 6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves (AT ALL VALVES), and hydrant branches in fire-suppression water-service piping according to NFPA 24 and the following:
 - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
 - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
 - 3. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.5 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box. **All curb valves shall be standard directional type (clockwise – close and counterclockwise – open).**
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- G. Support valves and piping, not direct buried, on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.6 DETECTOR CHECK VALVE INSTALLATION

- A. Install in vault or aboveground.
- B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
- C. Support detector check valves and piping on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.7 WATER METER INSTALLATION

- A. Install water meters, piping, and specialties according to utility company's written instructions.
- B. Water Meters: Install displacement-type water meters NPS 2 and smaller in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets, and include valved bypass around meters unless prohibited by authorities having jurisdiction.
- C. Water Meters: Install turbine-type water meters NPS 3 and larger in meter vaults. Include shutoff valves on water meter inlets and outlets, and include valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
- D. Water Meters: Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets, and include full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
- E. Support water meters and piping NPS 3 and larger on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.8 ROUGHING-IN FOR WATER METERS

- A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.9 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 and larger backflow preventers and piping on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.10 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valves at each check valve for fire-department connection to mains.
- B. Install protective pipe bollards on two sides of each freestanding fire-department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.11 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
- B. Supervisory Switches: Supervise valves in open position.
 - 1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 - 2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. Locking and Sealing: Secure unsupervised valves as follows:
 - 1. Valves: Install chain and padlock on open OS&Y gate valve.
 - 2. Post Indicators: Install padlock on wrench on indicator post.
- D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
- E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

- F. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in Section 284621.11 "Addressable Fire-Alarm Systems."

3.12 CONNECTIONS

- A. Connect fire-suppression water-service piping to utility water main. Use tapping sleeve and tapping valve.
- B. Connect fire-suppression water-service piping to interior fire-suppression piping.

3.13 FIELD QUALITY CONTROL

- A. Use test procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described below.
- B. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- C. Hydrostatic Tests: Test at not less than one-and-one-half times the working pressure for two hours.
 - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to zero psig. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- D. Prepare test and inspection reports.

3.14 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground fire-suppression water-service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."
- B. Permanently attach equipment nameplate or marker indicating plastic fire-suppression water-service piping or fire-suppression water-service piping with electrically insulated fittings, on main electrical meter panel. Comply with requirements for identifying devices in Section 220553 "Identification for Plumbing Piping and Equipment."

3.15 CLEANING

- A. Clean and disinfect fire-suppression water-service piping as follows:
 - 1. Purge new piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
 3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow it to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow it to stand for three hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

3.16 PIPING SCHEDULE

- A. Underground fire-suppression water-service piping NPS 2 and smaller shall be one of the following:
1. Soft copper tube, ASTM B 88, Type K; copper, pressure-seal fittings; and pressure-sealed joints.
 2. NPS 2 PE, Class 150, fire-service pipe; molded PE fittings; and heat-fusion joints.
- B. Underground fire-suppression water-service piping NPS 3 shall be one of the following:
1. Soft copper tube, ASTM B 88, Type K; copper, pressure-seal fittings; and pressure-sealed joints.
 2. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
 3. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
 4. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
 5. PE, Class 150, fire-service pipe; molded PE fittings; and heat-fusion joints.
- C. Underground fire-suppression water-service piping NPS 4 shall be one of the following:
1. Soft copper tube, ASTM B 88, Type K; copper, pressure-seal fittings; and pressure-sealed joints.
 2. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
 3. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern fittings; glands, gaskets, and bolts; and gasketed joints.

4. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
 5. PE, Class 150, fire-service pipe; molded PE fittings; and heat-fusion joints.
 6. PVC, Class 150 pipe listed for fire-protection service; PVC fittings of same class as pipe; and gasketed joints.
- D. Underground fire-suppression water-service piping NPS 6 to NPS 12 shall be one of the following:
1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
 2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
 3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
 4. PE, Class 150, fire-service pipe; molded PE fittings; and heat-fusion joints.
 5. PVC, Class 150 pipe listed for fire-protection service; PVC fittings of same class as pipe; and gasketed joints.
- E. Aboveground fire-suppression water-service piping NPS 2 and smaller shall be hard copper tube, ASTM B 88, Type L; wrought- or cast-copper-alloy, solder-joint fittings; and brazed joints.
- F. Aboveground fire-suppression water-service piping shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
 2. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
- G. Aboveground fire-suppression water-service piping NPS 5 to NPS 12 shall be grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.

3.17 VALVE SCHEDULE

- A. Underground fire-suppression water-service shutoff valves NPS 2 and smaller shall be corporation valves or curb valves with ends compatible with piping.
- B. Meter box fire-suppression water-service shutoff valves NPS 2 and smaller shall be meter valves.
- C. Vault fire-suppression water-service shutoff valves NPS 2 and smaller shall be Class 125, MSS, bronze, nonrising stem or UL-listed or FM Global-approved, OS&Y, bronze, gate valves.
- D. Underground fire-suppression water-service shutoff valves NPS 3 and larger shall be one of the following:
1. 200-psig, AWWA, iron, nonrising-stem, resilient-seated gate valves.
 2. 250-psig, AWWA, iron, nonrising-stem, resilient-seated gate valves.
 3. 175-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves.

- E. Indicator-post underground fire-suppression water-service valves NPS 3 and larger shall be 175-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves with indicator-post flange.
- F. Standard-pressure, aboveground fire-suppression water-service shutoff valves NPS 3 and larger shall be one of the following:
 - 1. 200-psig, AWWA, iron, OS&Y, resilient-seated gate valves.
 - 2. 250-psig, AWWA, iron, OS&Y, resilient-seated gate valves.
 - 3. 175-psig, UL-listed or FM Global-approved, iron, OS&Y gate valves.
 - 4. AWWA or UL-listed or FM Global-approved butterfly valves.
- G. Fire-suppression water-service check valves NPS 3 and larger shall be one of the following:
 - 1. AWWA or UL-listed or FM Global-approved check valves.
 - 2. UL-listed or FM Global-approved detector check valves.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Review system flushing design with OUA to meet NFPA 25 flushing requirements. Flushing and pressure testing is required for all design installations.
- C. Underground service piping shall have all joint seams sealed with tape.
- D. Victaulic Style 109 Firelock one bolt rigid coupling is not acceptable for installation on projects.

END OF SECTION 211100

KSU DESIGNERS NOTES:

- 1. Fire main entrance details and distribution main lines shall be indicated on the contract documents.
- 2. Backflow protection shall be provided with an approved double check valve. Review manufactures with OUA: Ames, Conbraco, and Watts preferred.
- 3. Fire lines are to be provided with post indicator valve and tamper switch, thrush restrains, backflow and shall be reviewed with OUA and AHJ. Fire department

connections shall have Stortz connection with Knox Box. Review Knox Box requirements with OUA.

SECTION 211116 - FACILITY FIRE HYDRANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. AWWA dry-barrel fire hydrants.

- B. Related Requirements:

- 1. Section 211100 "Facility Fire-Suppression Water-Service Piping" for piping and specialties for facility fire-suppression water-service piping outside the building and for service entrance piping into the building at the floor slab or wall.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire hydrants to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 AWWA DRY-BARREL FIRE HYDRANTS

- A. Description: Post type, with one NPS 4-1/2 and two NPS 2-1/2 outlets; and with 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body and compression-type valve that opens against pressure and closes with pressure.
- B. Standard: AWWA C502.
 - 1. Pressure Rating: 150 psig minimum.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire hydrants.
- B. Examine roughing-in for facility fire-suppression water-service piping to verify actual locations of piping connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. Dry-Barrel Fire Hydrants: Install with valve below the frost line. Provide for drainage.
- C. AWWA Fire Hydrants: Comply with AWWA M17.

PART 4 - SUPPLEMENTAL REQUIREMENTS**4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS**

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

END OF SECTION 211116

KSU DESIGNERS NOTES:

1. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
2. Coordinate and refer to local municipality fire hydrant details for specific features and installation requirements.
3. Fire hydrant shall be "Mueller Centurion" or approved equal in accordance with City of Kent.

SECTION 211119 – FIRE DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Yard-type fire-department connections.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

PART 2 - PRODUCTS

2.1 YARD-TYPE FIRE-DEPARTMENT CONNECTION

- A. Standard: UL 405.
- B. Type: Exposed, freestanding.
- C. Pressure Rating: 175 psig minimum.
- D. Body Material: Corrosion-resistant metal.
- E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- F. Caps: Brass, lugged type, with gasket and chain.
- G. Escutcheon Plate: Round, brass, floor type.
- H. Outlet: Bottom, with pipe threads.
- I. Number of Inlets: (1) 4" Storz.

- J. Sleeve: Brass.
- K. Sleeve Height: 18 inches.
- L. Provide with locking cap (keyed center). Coordinate keying with KSU OUA.
- M. Escutcheon Plate Marking: Similar to "AUTO SPKR" or "STANDPIPE" or "STANDPIPE AND AUTO SPKR" indicating type of system within building.
- N. Finish, Including Sleeve: Rough brass or bronze.
- O. Exterior riser piping shall be painted with durable red paint – coordinate final color with the OUA.
- P. Outlet Size: NPS 4.

2.2 KNOX BOX

- A. Contractor to provide and install Knox Box purchased and registered through Kent State Life Safety.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
- B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."
- B. Install minimum of two protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."
- C. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Fire department connection to be 4" "Storz" type for Kent campus; all Regional campuses to review with local fire department prior to design. Exterior riser piping shall be painted with durable red paint – coordinate final color with the OUA. Device shall be permanently labeled for use.

END OF SECTION 211119

KSU DESIGNERS NOTES:

1. The Yard-Type Fire-Department Connection shall be located outside of the building collapse zone. Consult with OUA for final location.
2. A metal ring shall be provided around the storz connection.

SECTION 211200 - FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only relevant items to project.

1. Pipes, fittings, and specialties.
2. Fire-protection specialty valves.
3. Hose connections.
4. Alarm devices.
5. Pressure gages.

- B. Related Requirements:

Retain only relevant sections to project.

1. Section 210523 "General-Duty Valves for Water-Based Fire-Suppression Piping."
2. Section 211119 "Fire-Department Connections" for exposed wall-mounted and yard fire hydrants.
3. Section 211313 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.

1.3 DEFINITIONS

- A. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig maximum.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fire-suppression standpipes.
1. Include plans, elevations, sections, and attachment details.
 2. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and professional engineer.
- B. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- C. Welding certificates.
- D. Fire-hydrant flow test report.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Suppression Standpipe Service: Do not interrupt fire-suppression standpipe service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression standpipe service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-suppression standpipe service.
2. Do not proceed with interruption of fire-suppression standpipe service without Owner's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTIONS

- A. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
- B. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.

2.2 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig minimum working pressure.
- B. High-Pressure, Fire-Suppression Standpipe System Component: Listed for 250-psig minimum working pressure.
- C. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.
 1. Minimum residual pressure at each hose-connection outlet is as follows:
 - a. NPS 2-1/2 Hose Connections: 100 psig.

2.3 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials and for joining methods for specific services, service locations, and pipe sizes.

2.4 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

- A. Schedule 40: ASTM A 135/A 135M, Grade A; with factory- or field-formed ends to accommodate joining method.
- B. Schedule 10: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- C. Uncoated, Steel Couplings: ASTM A 865/A 865M, threaded.
- D. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

- E. Malleable- or Ductile-Iron Unions: UL 860.
- F. Cast-Iron Flanges: ASME B16.1, Class 125.
- G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- I. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Pressure Rating: 175 psig minimum.
 - 2. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.5 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.6 SPECIALTY VALVES

- A. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
 - 2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
 - b. High-Pressure Piping Specialty Valves: 250 psig minimum.
 - 3. Body Material: Cast or ductile iron.
 - 4. Size: Same as connected piping.
 - 5. End Connections: Flanged or grooved.

2.7 HOSE CONNECTIONS

- A. Adjustable-Valve Hose Connections:

1. Standard: UL 668 hose valve, with integral UL 1468 reducing or restricting pressure-control device, for connecting fire hose.
2. Pressure Rating: 300 psig minimum.
3. Material: Brass or bronze.
4. Size: NPS 1-1/2 or NPS 2-1/2, as indicated.
5. Inlet: Female pipe threads.
6. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
7. Pattern: Angle.
8. Pressure-Control Device Type: Pressure reducing.
9. Design Outlet Pressure Setting: 300 psig.
10. Finish: Polished chrome-plated.

B. Nonadjustable-Valve Hose Connections:

1. Standard: UL 668 hose valve for connecting fire hose.
2. Pressure Rating: 300 psig minimum.
3. Material: Brass or bronze.
4. Size: NPS 2-1/2, as indicated.
5. Inlet: Female pipe threads.
6. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
7. Pattern: Angle.
8. Finish: Polished chrome-plated.

2.8 ALARM DEVICES

Retain only relevant items to project.

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:

1. Standard: UL 753.
2. Type: Mechanically operated, with pelton wheel.
3. Alarm Gong: Cast aluminum with red-enamel factory finish.
4. Size: 10-inch diameter.
5. Components: Shaft length, bearings, and sleeve to suit wall construction.
6. Inlet: NPS 3/4.
7. Outlet: NPS 1 drain connection.

C. Electrically Operated Alarm Bell:

1. Standard: UL 464.
2. Type: Vibrating, metal alarm bell.
3. Size: 6-inch minimum diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:

1. Standard: UL 346.

2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

E. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.

F. Indicator-Post Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.9 PRESSURE GAGES

- A. See Specification Section 210519 "Meters and Gages for Fire Suppression Piping" for pressure gage requirements.
- B. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 SERVICE-ENTRANCE PIPING

- A. Connect fire-suppression standpipe piping to water-service piping at service entrance into building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories at connection to fire-suppression water-service piping. Comply with requirements for backflow preventers in Section 211100 "Facility Fire-Suppression Water-Service Piping."
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.4 WATER-SUPPLY CONNECTIONS

- A. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.5 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.
- C. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
- D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install drain valves on standpipes. Extend drain piping to outside of building.
- F. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.
- G. Install alarm devices in piping systems.

- H. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.
- I. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- J. Fill wet-type standpipe system piping with water.

Retain only relevant items to project.

- K. Install electric heating cables and pipe insulation on wet-type fire-suppression standpipe piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."
- L. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- M. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.6 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- J. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.
1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.7 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.8 HOSE-CONNECTION INSTALLATION

- A. Install hose connections adjacent to standpipes.
- B. Install freestanding hose connections for access and minimum passage restriction.
- C. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device.

3.9 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type fire-department connections.
- B. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."
 - 1. Install protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."
- C. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.10 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire-department equipment.
- C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.13 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 4 and larger, shall be one of the following:
 - 1. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 2. Schedule 10, black-steel pipe with plain ends; welding fittings; and welded joints.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Victaulic Style 109 Firelock one bolt rigid coupling is not acceptable for installation on projects.

END OF SECTION 211200

KSU DESIGNERS NOTES:

- 1. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.**
- 2. Review system flushing design with OUA to meet NFPA 25 flushing requirements. Flushing and pressure testing is required for all design installations. Consultants to comply with all NFPA and AHJ. All flushed debris shall be captured.**

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only relevant sections to project.

- 1. Pipes, fittings, and specialties.
- 2. Cover system for sprinkler piping.
- 3. Specialty valves.
- 4. Sprinklers.
- 5. Alarm devices.
- 6. Pressure gages.

- B. Related Requirements:

Retain only relevant specification sections to project.

- 1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.

1.3 DEFINITIONS

- A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than 250 psig.
- B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.

2. Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Domestic water piping.
 2. Compressed air piping.
 3. HVAC hydronic piping.
 4. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- B. Qualification Data: For qualified Installer and professional engineer.
- C. Design Data:
 1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Welding certificates.
- E. Field Test Reports:
 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 2. Fire-hydrant flow test report.
- F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.9 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
 1. Notify Owner no fewer than seven days in advance of proposed interruption of sprinkler service.
 2. Do not proceed with interruption of sprinkler service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

Edit NFPA 13 or 13R as relevant to project.

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 1. NFPA 13.
 2. NFPA 13R.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.
- D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - b. Sprinkler Occupancy Hazard Classifications:
 - 1) Automobile Parking Areas: Ordinary Hazard, Group 1.
 - 2) Building Service Areas: Ordinary Hazard, Group 1.
 - 3) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - 4) General Storage Areas: Ordinary Hazard, Group 1.
 - 5) Laundries: Ordinary Hazard, Group 1.
 - 6) Libraries except Stack Areas: Light Hazard.
 - 7) Library Stack Areas: Ordinary Hazard, Group 2.
 - 8) Machine Shops: Ordinary Hazard, Group 2.
 - 9) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - 10) Office and Public Areas: Light Hazard.
 - 11) Plastics Processing Areas: Extra Hazard, Group 2.
 - 12) Printing Plants: Extra Hazard, Group 1.
 - 13) Residential Living Areas: Light Hazard.
 - 14) Restaurant Service Areas: Ordinary Hazard, Group 1.
2. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Residential (Dwelling) Occupancy: 0.05 gpm over 400-sq. ft. area.
 - b. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - c. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - d. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
 - e. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
 - f. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
 - g. Special Occupancy Hazard: As determined by authorities having jurisdiction.
3. Maximum Protection Area per Sprinkler: According to UL listing.
4. Maximum Protection Area per Sprinkler:
 - a. Residential Areas: 400 sq. ft.
 - b. Office Spaces: 225 sq. ft.
 - c. Storage Areas: 130 sq. ft.
 - d. Mechanical Equipment Rooms: 130 sq. ft..
 - e. Electrical Equipment Rooms: 130 sq. ft..
 - f. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

2.2 STEEL PIPE AND FITTINGS

- A. Schedule 40, Black-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M; or ASME B36.10M wrought steel, with wall thickness not less than Schedule 40 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

- C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.
- E. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - 1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
 - 1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Pressure Rating: 175-psig minimum.
 - 2. Uncoated Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- K. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

- F. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- G. Copper Pressure-Seal Fittings:
 - 1. Standard: UL 213.
 - 2. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - 3. NPS 2-1/2 to NPS 4: Cast-bronze fitting with EPDM-rubber O-ring seal in each end.
- H. Grooved-Joint, Copper-Tube Appurtenances:
 - 1. Grooved-End Copper Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
 - 2. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

2.4 CPVC PIPE AND FITTINGS

- A. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig rated pressure at 150 deg F, with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.
- B. CPVC Fittings: UL listed, for 175-psig rated pressure at 150 deg F, socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.
 - 1. NPS 3/4 to NPS 1-1/2: ASTM F 438 and UL 1821, Schedule 40, socket type.
 - 2. NPS 2 to NPS 3: ASTM F 439 and UL 1821, Schedule 80, socket type.
 - 3. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
 - 4. CPVC-to-Metal Transition Unions: CPVC, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
 - 5. Flanges: CPVC, one or two pieces.
- C. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493 solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.
- D. Plastic Pipe-Flange Gasket and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 COVER SYSTEM FOR SPRINKLER PIPING

- A. Description: System of support brackets and covers made to protect sprinkler piping.
- B. Brackets: Glass-reinforced nylon.
- C. Covers: Extruded-PVC sections of length, shape, and size required for size and routing of CPVC piping.

2.6 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
 - 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
 - 2. High-Pressure Piping Specialty Valves: 250-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Alarm Valves:
 - 1. Standard: UL 193.
 - 2. Design: For horizontal or vertical installation.
 - 3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
 - 4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
 - 5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 - 6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Automatic (Ball Drip) Drain Valves:
 - 1. Standard: UL 1726.
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Type: Automatic draining, ball check.
 - 4. Size: NPS 3/4.
 - 5. End Connections: Threaded.

2.7 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:
 - 1. Standard: UL 213.
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - 4. Type: Mechanical-tee and -cross fittings.
 - 5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 - 6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 - 7. Branch Outlets: Grooved, plain-end pipe, or threaded.
- B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250-psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175-psig minimum.
4. Size: Same as connected piping, for sprinkler.

2.8 SPRINKLERS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating for Residential Sprinklers: 175-psig maximum.
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

- D. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.
- E. Automatic Sprinklers with Heat-Responsive Element:
 - 1. Early-Suppression, Fast-Response Applications: UL 1767.
 - 2. Nonresidential Applications: UL 199.
 - 3. Residential Applications: UL 1626.
 - 4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- F. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
 - 1. Nominal Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
 - 2. Nominal Orifice: 17/32 inch with discharge coefficient K between 7.4 and 8.2.
- G. Sprinkler Finishes: painted.
- H. Special Coatings: Corrosion-resistant paint.
- I. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: Plastic, white finish, one piece, flat.
 - 2. Sidewall Mounting: Plastic, white finish, one piece, flat.
- J. Sprinkler Guards:
 - 1. Standard: UL 199.
 - 2. Type: Wire cage with fastening device for attaching to sprinkler.

2.9 ALARM DEVICES

Retain only relevant items to project.

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
 - 1. Standard: UL 753.
 - 2. Type: Mechanically operated, with Pelton wheel.
 - 3. Alarm Gong: Cast aluminum with red-enamel factory finish.
 - 4. Size: 8-1/2-inches diameter.
 - 5. Components: Shaft length, bearings, and sleeve to suit wall construction.
 - 6. Inlet: NPS 3/4.
 - 7. Outlet: NPS 1 drain connection.
- C. Electrically Operated Alarm Bell:
 - 1. Standard: UL 464.

2. Type: Vibrating, metal alarm bell.
3. Size: 6-inch minimum- diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

E. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.10 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch diameter. Provide isolation valve (ball) at pressure gage.
- C. Pressure Gage Range: 0- to 250-psig minimum.
- D. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping" for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 211100 "Facility Fire-Suppression Water-Service Piping."
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.4 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

- D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- J. Install alarm devices in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- M. Fill sprinkler system piping with water.
- N. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.5 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- N. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- O. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

- P. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
- Q. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- R. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.6 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

3.7 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
 - 3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.8 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

- D. Install corrosion resistant sprinklers in chemical storage rooms.

3.9 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Coordinate with fire-pump tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.11 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.12 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.13 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: [Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.](#)

- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.

Verify below with KSU OUA.

- D. CPVC pipe, Schedule 40 or 80 CPVC fittings, and solvent-cemented joints may be used for light-hazard and residential occupancies.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 3 and smaller, shall be one of the following:
 - 1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 40, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 - 3. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 4. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 - 5. Type L, hard copper tube with plain ends; cast- or wrought-copper, solder-joint fittings; and brazed joints.
 - 6. Type L, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
 - 7. NPS 3, Type L, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
- F. Standard-pressure, wet-pipe sprinkler system, NPS 4 and larger, shall be one of the following:
 - 1. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 2. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.
 - 3. Type L, hard copper tube with plain ends; cast- or wrought-copper, solder-joint fittings; and brazed joints.
 - 4. Type L, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

3.14 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Pendent, dry sprinklers and sidewall, dry sprinklers as indicated.
 - 5. Special Applications: Extended-coverage and quick-response sprinklers where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: White sprinkler with painted white escutcheon.
3. Recessed Sprinklers: White sprinklers with painted white escutcheon.
4. Residential Sprinklers: White sprinklers with painted white escutcheon.
5. Pendent and Sidewall Sprinklers: White in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Furnish extra sprinkler heads per NFPA. Cabinet(s) shall be mounted as directed by the OUA. Include associated escutcheons and protect all in sealed plastic bags.
- C. Flexible sprinkler head connectors are acceptable provided they are UL and FM approved.
- D. Quick adjust, single strap tap-in fittings shall not be permitted. All fittings shall be approved by OUA.
- E. Mechanical Tees's fittings with gasket having a single u-bolt mounting configuration are not permitted for use under any condition.
- F. Victaulic Style 109 Firelock one bolt rigid coupling is not acceptable for installation on projects.
- G. Adjustable stem fitting shall also be prohibited.
- H. Sprinkler piping shall not be in contact with any other piping, conduit, cable, etc.
- I. Sprinkler drain piping shall terminate to the outdoors with a 45-degree elbow and discharge onto a concrete splash block. Drain piping shall be painted color as selected by architect. OUA standard color is "RED" for sprinkler system piping.

END OF SECTION 211313

KSU DESIGNERS NOTES:

1. **General Requirements: The Associate shall comply with all necessary building codes pertaining to the fire protection requirements. Associate will also obtain flow test information from the local authority. Submit all testing data to the OUA.**
2. **Associate shall verify Factory Mutual requirements since their requirements may be stricter than the Ohio Basic Building Code and NFPA.**

3. Design drawings are to indicate fire and smoke rated walls and shall indicated wall ratings on all design documents, fire stopping requirements and details shall be reviewed with OUA.
4. Fire main entrance details and distribution main lines shall be indicated on the contract drawings. Sprinkler head installation details (center of tile preferred), isolation and test drain design (discharge all testing outlets to the outdoors on concrete splash blocks) All of these locations shall be shown. Not intended to be hydraulic installation drawings- but for overall building design coordination.
5. Systems:
 - a. Fire suppression for kitchen hoods shall be a wet chemical system. Dry chemical systems will not be allowed.
 - b. Halon systems will not be permitted.
 - c. Carbon dioxide systems shall be avoided. Special permission must be granted to the Associate by OUA and KSU Fire Marshal.
 - d. Use of glycol systems shall be reviewed with OUA.
 - e. Clean agent fire system shall be DuPont FM-200 or Ansul-Inergen (data closets, data centers, high asset value areas). Review with OUA.
6. Coordinate Blazemaster or similar systems with OUA and obtain approval in writing.
7. Coordinate Special Areas requiring sprinklers with OUA.
8. Sprinkler Heads in Occupied Areas: Concealed style head with white escutcheons and white heads are preferred in high end occupied areas; recessed in most occupied areas where approved by OUA. White escutcheons and heads preferred. If optional colors are required- must be approved by OUA and Sprinkler Head manufacturer to maintain ratings.
9. Sprinkler heads in mechanical, electrical, data closet and elevator equipment rooms shall be standard brass pendant or upright style with protective wire basket and 212 deg. rating. Review with OUA.
10. Valves and Fire Alarm Devices for Fire Protection Systems: Consult with OUA for specific requirements. Backflow based on system pressure needs.
11. Miscellaneous Equipment and Specialties: Backflow protection shall be provided with an approved double-check valve. Review manufacturers with OUA; Watts, Ames and Conbraco preferred.
12. Review system flushing design with OUA to meet NFPA 25 flushing requirements. Flushing and pressure testing is required for all design installations. Consultants to comply with all NFPA and AHJ.
13. Test nozzles shall be directed outside whenever possible. Directing the test discharge to a slop sink or floor drain should be avoided due to damage of over-spray and/or over-loading of the drain line. Test nozzles directed outside shall be located such that the spray will not affect pedestrians or damage lawns. Concrete splash blocks shall be provided when location requires. Review alternate testing devices with OUA.

14. A pressure gage with ball valve and double check valve (similar to Watts 904) shall be installed at all limited area sprinkler connections to the domestic water system. Limited area sprinkler system piping shall be of a material matching the domestic water system to which it is connected.
15. Fire pumps shall be avoided when possible due to increased generator size and maintenance requirements. When required, system shall be reviewed with the OUA. Bell & Gossett, Peerless, Patterson, or equivalent per OUA approval.

KENT STATE UNIVERSITY

MASTER SPECIFICATIONS

DIVISION 22

220500	Common Work Results for Plumbing
220501	Basic Mechanical Materials and Methods for Plumbing
220513	Common Motor Requirements for Plumbing Equipment
220517	Sleeves and Sleeve Seals for Plumbing
220518	Escutcheons for Plumbing Piping
220519	Meters and Gages for Plumbing Piping
220523	General Duty Valves and Strainers
220529	Hangers and Supports for Plumbing Piping and Equipment
220553	Identification for Plumbing Piping and Equipment
220716	Plumbing Equipment Insulation
220719	Plumbing Piping Insulation
221116	Domestic Water Piping
221119	Domestic Water Piping Specialties
221123	Facility Natural-Gas Piping
221123.13	Domestic-Water Packaged Booster Pumps
221123.21	Inline, Domestic-Water Pumps
221316	Sanitary Waste and Vent Piping
221319	Sanitary Waste Piping Specialties
221319.13	Sanitary Drains
221413	Facility Storm Drainage Piping
221423	Storm Drainage Piping Specialties
221429	Sump Pumps
223300	Water Heaters
224213	Commercial Plumbing Fixtures
224500	Emergency Plumbing Fixtures

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 GENERAL REFERENCE

Retain or edit sections below as they pertain to the project.

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to work of this section.
- B. Refer to Division 01 section "Alternates" for possible alternates affecting the extent of this Section of work.

Retain below only if it is applicable to the project. Coordinate Specification number below.

- C. Specification Section 018113.13 Sustainable Design Requirements apply to work specified in this section.
- D. Specification Section 018113c Indoor Air Quality Management Plan during construction apply to work specified in this section.
- E. This Contractor is also referred to the Mechanical, Architectural, Structural, Electrical and all other drawings and specifications pertinent to this project. All of the above mentioned drawings and specifications are considered a part of the Contract Documents.
- F. This section specifies the basic requirements for Plumbing installations and includes requirements common to more than one section of Division 22. It expands and supplements the requirements specified in sections of Division 01.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

Select one of the two paragraphs after coordinating with the Architect. Paragraph "A" is for one prime contractor, "B" is for multiple contractors.

- H. The term "Contractor" as applied to work specified, shown or reasonably implied in the contract documents for Division 22 shall be defined as the subcontractor who is responsible for the work specified or indicated. All subcontracted work must be incorporated by and coordinated by the prime contractor.
- I. The term "Contractor" as applied to work specified, shown or reasonably implied in the contract documents for Division 22 shall be defined as the each prime contractor who is responsible for the work specified, or indicated. All work subcontracted to each prime contractor must be incorporated by and coordinated by each prime contractor.

Use Paragraph "C" below if the Engineer is the lead design professional, "D" if the Architect is the lead. Fill in blank with Engineering firm.

- J. Throughout this specification section the term "Design Professional" is referenced. The specification calls for certain actions to be undertaken or referred to the Design Professional. Accordingly, the term "Design Professional" shall be defined as the firm with which the "Owner" has contracted to produce the contract drawings and specifications. It shall be understood that the Design Professional for this project is .
- K. Throughout this specification section the term "Design Professional" is referenced. The specification calls for certain actions to be undertaken or referred to the Design Professional. Accordingly, the term "Design Professional" shall be defined as the firm with which the "Owner" has contracted to produce the contract drawings and specifications. It shall be understood that the Design Professional for this project is the Architect whose name is shown on the drawing title block.

1.3 QUALITY ASSURANCE

- A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at the expense of the Plumbing contractor. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.4 PLUMBING COORDINATION

- A. This Contractor shall familiarize himself with the work to be done under other Divisions of this specification and their related drawings and shall so coordinate and schedule his work as not to cause delays or interference with the work of others. Such coordination and scheduling shall

accomplish the installation of equipment and piping with a minimum of cutting through masonry and other adjustments.

- B. Ceiling grid systems shall not be supported from plumbing lines or any other utility lines, and vice versa. Each utility and the ceiling grid system shall be a separate installation and each shall be independently supported from the building structure-concrete, steel or masonry. Where interferences occur, in order to support piping, ceiling grid systems, etc., trapeze type hangers or supports shall be employed which shall be located so as not to interfere with access to such plumbing equipment as valves, regulators, etc.

The following requirement for each contractor to be responsible for their own openings is preferred. Coordinate with Architect and Section 220501.

- C. This Contractor shall be responsible for proper size and location of pipe spaces, anchors, chases, recesses, slots and openings, etc., required for the proper installation of his work during progress of construction to allow for plumbing installations. Verify all dimensions by field measurements. Coordinate the installation of required supporting devices and sleeves in structural components as they are constructed. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the work.
- D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors.
- F. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- G. Allow ample space for removal of all parts that require replacement or servicing. Extend all grease fittings to an accessible location. Install equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with a minimum of interference with other installations. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the work.
- H. All plumbing equipment, especially piping, shall be at least three feet away horizontally from any electrical switchgear or transformers. No hydronic lines shall pass through telephone, transformer, switchgear rooms or elevator equipment rooms.
- I. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

Coordinate the following items with the Architect and edit accordingly.

- A. Specific divisions of responsibility when coordinating with trades other than plumbing shall be as indicated on drawings, in Division 01, as follows. The Contractors under this Division shall:
 - 1. Run the indicated utilities outside the building to points as noted on the drawings. He shall be responsible for the actual tie-in to street utility services where routing to site utility services on drawings pertaining to this Division are indicated.

2. Provide and place all sleeves in floors, walls, etc., and coordinate such location.
3. Be responsible for flashing at roof vent terminals.
4. Rough-in and connect all equipment furnished by other trades or Owner where shown on the drawings.
5. Provide motors, special controls, transformers and relays as required for the proper operation of all equipment furnished by him under this Division.
6. Coordinate the location of floor drains and cleanouts with architectural and structural elements or work of other trades affecting the location of floor drains and cleanouts. Where floor drains are installed to serve specific pieces of equipment, coordinate the location of floor drains with the contractor who is providing the equipment, using manufacturer's shop drawings for the equipment served or written instructions from the equipment manufacturer.

1.5 EXAMINATION OF SITE

- A. Before submitting a bid, the Contractor is requested to visit the job site to familiarize himself with construction conditions. No consideration or remuneration will be given for his failure to do so.

1.6 DIVISION 22 DESIGN DOCUMENTS

Select one of the following two paragraphs. "A" is for projects with one Prime Contractor. "B" is for projects with multiple Prime Contractors.

- A. Should it appear that there is a discrepancy between or within the drawings and/or specifications concerning the nature, quality or extent of materials or work to be furnished and/or installed, and such discrepancy is not clarified by Addendum during the bidding period, this Contractor shall base his bid on performing the work in the manner having the higher cost. The Design Professional shall have the option of selecting either of the manners shown and/or specified. In the event the lower cost manner is selected, a credit shall be due the Owner in the amount of the difference between the lower cost and higher cost manner. Any discrepancies shall be called to the attention of the Design Professional before proceeding with work affected thereby.
- B. Should it appear that there is a duplication on the Drawings or in the Specifications, wherein the same work or items are shown or specified as being provided under different contracts, subcontracts or supply orders, and such duplication is not clarified by Addendum during the bidding period, it shall be assumed that the prime contractors have included duplicate quotations in their proposal to the Owner. The Design Professional shall have the option of selecting the contract, subcontract or supply order under which the work or items are to be provided and a credit shall be due the Owner for the duplicate work or items.
- C. Where a discrepancy exists within the specifications, among the drawings, or between the specifications and the drawings, refer to project supplementary conditions.
- D. Should it appear that there is a duplication on the drawings or in the specifications, wherein the same work or items are shown or specified as being provided under separate subcontracts or supply orders, and such duplication is not clarified by addendum during the bidding period, it shall be assumed that the responsible prime contractor will select and coordinate which subcontract will supply the item and the item will be supplied as indicated. Occasionally, certain

references may be indicated on the Drawings to items which are suggested to be furnished and/or installed by various subcontractors. This is done to assist the applicable Prime Contractor in organizing his subcontractor's bids. However, no attempt has been made, nor is it implied, that this specification or plans are attempting to specifically divide all responsibilities for subcontractors. It is the Prime Contractor's responsibility that all items covered on Plumbing plans and Division 22 specifications are included in his bid and are coordinated with his subcontractors. No consideration will be given for Prime Contractor's failure to include all applicable plumbing work in his bid.

- E. The design drawings, as submitted, are diagrammatic and are not intended to show exact location of equipment and piping unless dimensions are given. Drawings are not to be scaled.
 - 1. Equipment shall be installed along the general arrangement indicated on the drawings, and in accordance with the manufacturer's instructions.
 - a. Provide at least the minimum manufacturer's recommended and code required clearance around the equipment for normal maintenance.
 - b. Locate and arrange equipment in relationship to other system components to assure that the equipment will be operating under the best possible conditions to meet the scheduled performance requirements.
 - 2. Piping is to be installed along the general plans shown on the drawings keeping in mind the constraints of the available space and the need to coordinate with the work of other trades. Additional offset and fittings shall be provided as necessary to meet space constraints and to facilitate the work of other trades.
 - a. Recognizing the potential need for additional offsets and fittings in piping, the Engineer has included a safety factor in all friction calculations. The Contractor is advised to plan and coordinate his work carefully to minimize the need for additional offsets and fittings. The Contractor shall be responsible to notify the Engineer of any and all modifications to systems which may affect the ability of equipment to serve its intended use prior to the purchase and installation of such equipment.
- F. All equipment, piping and material specified hereinafter as shown on the drawings shall be furnished and installed by this Contractor, unless specifically indicated to the contrary.
- G. If this Contractor proposes to install equipment requiring space conditions other than those as specified and/or shown on the design drawings, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall obtain the full approval of the Design Professional before proceeding with the work.

1.7 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements of this division, and in Division 01.

- B. This Contractor shall record all changes from original design drawings which were made during the installation of the work. These changes shall be recorded in red ink on a designated set of prints. Changes shall be accurately dimensioned and/or drawn to scale.
- C. This Contractor shall keep an updated set of specifications and prints, including changes on the job site, at all times and shall submit one (1) set of updated and legible prints to the Design Professional when the work is complete.

1.8 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades under this Division shall submit coordination drawings in AutoCAD, drawn to scale ($\frac{1}{4}"=1'-0"$ or larger) for review. Refer to project schedule for required submission dates. Such drawings will be required throughout all areas for all trades. The requirements for Coordination Drawings are specified in Division 23 and are reprinted below:
 - 1. The HVAC Contractor shall prepare the base plan coordination drawings showing all ductwork, all pertinent heating piping and equipment. The drawings shall be coordinated with lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearances, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Architect and Engineer. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of contract. Minor revisions need not be redrawn.
 - 2. HVAC Contractor shall provide the base plan in AutoCad and submit the base plan to all major trades' Contractors. All ductwork and piping shall be on separate layers.
 - 3. The Fire Protection Contractor shall draft location of piping, sprinkler heads and equipment on the base plan using a separate layer, indicating areas of conflict and suggested resolutions.
 - 4. The Plumbing Contractor shall draft location of all piping and equipment on the base plan using a separate layer.
 - 5. The Electrical Contractor shall draft location of lighting fixtures, cable trays, and feeders over 2 in. on the base plan using a separate layer, indicating areas of conflict and suggested resolution.
 - 6. The HVAC Contractor shall then combine all layers on a composite AutoCad drawing indicating all areas of conflict.
 - 7. The General Trades Contractor shall indicate areas of architectural/structural conflicts or obstacles and coordinate to suit the overall construction schedule.
 - 8. The Construction Manager shall expedite all drawing work and coordinate to suit the overall construction schedule. He shall then review these drawings and compare them with the architectural, structural, equipment and other drawings and determine that all of the work can be installed without interference. In the case of unresolved interferences, he shall notify the Architect. The Architect will then direct the various Contractors as to how to revise their drawings as required to eliminate installation interferences.
 - 9. If a given trade proceeds prior to resolving conflicts, then, if necessary, that trade shall change its work at no extra cost in order to permit others to proceed with a coordinated installation. Coordination approval will be given for individual areas after special site meetings involving all Trades.

10. Coordination drawings are intended for the respective Contractor's use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these contract documents.
11. After resolution of all conflicts, all trades shall sign and date a hard copy of the composite coordination drawing.

1.9 SHOP DRAWINGS

- A. Refer to the conditions of the Contract (General and Supplementary) and Division 01 Section: Shop drawings, product data, and samples for submittal definitions, requirements, and procedures. Refer to project schedule for required submission dates.

Retain above if there is a Division 01 specification with the project. If not, include the paragraph below.

- B. Submit electronic copy of shop drawings to the Design Professional.
- C. This Contractor shall review, stamp and sign with his approval and submit, with reasonable promptness and in orderly sequence so as to cause no delay in the work or in the work of any other Contractor, all submittal information required by the contract documents. Shop drawings not stamped with Contractor approval will be returned for reprocessing.
 1. Shop drawings shall only cover equipment or components that are being provided. Failure to edit shop drawings and options will be reason for rejection.
 2. In approving the submittals, the Contractor guarantees that the submittals accurately and completely represent the equipment and materials to be installed.
 3. Shop drawings shall be submitted for ALL material items as outlined in these specifications. Any deviations from contract requirements must be clearly indicated on shop drawings, and justification for their consideration must be included.
 4. Acceptance of submittal items will not preclude rejection of those items upon later discovery that their suitability for the application or ability to meet the requirements of these specifications was misrepresented in the submittals.
 5. Equipment shop drawings shall include nameplate data, model number and efficiency rating along with full load amps for all electrical motors.
 6. Submittals for equipment shall include detailed dimensional drawings which completely and accurately represent the specific piece of equipment to be supplied. When more than one piece of similar equipment is to be supplied, provide accurate dimensional drawings for each unique size and/or configuration of the equipment.
- D. In checking shop drawings, the Design Professional will make every effort to detect and correct errors, omissions and inaccuracies in such drawings, but his failure to detect errors, omissions and inaccuracies shall not relieve the Contractor of responsibility for the proper and complete installation in accordance with the intent of the Contract Documents.

1.10 EQUIPMENT

- A. Before entering into a contract, the successful bidder may be required to submit satisfactory evidence to show that the manufacturer of all parts of the equipment offered have been regularly engaged in the manufacture of such equipment for three (3) years and have not less than three (3) installations of a similar type which have been in successful operation under conditions similar to those specified for not less than two (2) years.
- B. When two or more items of same equipment are required (plumbing fixtures, pumps, valves, etc.) they shall be of the same manufacturer.
- C. In placing his bid, the Contractors under this Division shall take note that manufacturer's products change frequently, and only the scheduled products have been checked by the Engineer for compliance with the Contract Documents and physical characteristics. Other manufacturers are listed because they are believed to be capable of complying, and in order to achieve fair and competitive bidding. However, it is the responsibility of the manufacturer in his relationship with the Contractor to bid to the Contractor only products complying with the Contract Documents, and the responsibility of the Contractor to base his bid only on manufacturers which do comply. No consideration will be given to the Contractor for his failure to do this. Should Contractors during the bidding process discover that listed manufacturers cannot comply with the Documents, they are encouraged to contact the Engineer as soon as practical, and provided sufficient time in the bidding process exists, and the Engineer agrees with the request, the Engineer will attempt to adjust the documents in the addendum process. If no addendum is issued adjusting the requirements so that all listed manufacturers can bid, the Contractor will be required to supply one of the listed manufacturers which comply with the Contract Document requirements.

1.11 SUBSTITUTIONS

- A. Refer to the Instructions to Bidders and the related Division 01 sections for requirements in selecting products and requesting substitutions.

Make sure Division 01 addresses substitutions, if not include paragraphs B&C below. If covered in Division 01, delete paragraphs B&C.

- B. Bids concerning the use of substitute products must be accompanied by complete specifications and performance characteristics covering these products, together with such available test data and experience records as may be helpful to the Design Professional in evaluating the quality and/or suitability of the proposed products.
- C. The intent of this paragraph is to make the specifications open to all available makes of material and apparatus during the bidding period. Certain definite makes or kinds of items are specified as "standards of quality" and character required. Each Contractor is required to bid upon the basis of furnishing the makes specified. He is also invited to bid on any other similar makes he (the Contractor) may desire to propose as substitutions, stating any difference in cost for each proposed substitution on the Substitution Sheet, if there is a difference. If the Design Professional shall decide to accept any of the proposed substitutions, proper notations thereof shall be made in the written contract. Where several makes are mentioned in the specifications and the Contractor fails to state that he prefers a particular make in his bid, the Owner shall have the right to choose any of the makes mentioned without change in price. No consideration will be given to proposals for alternative products unless submitted with the original bids.

1.12 SUPERVISION

Coordinate whether a full time superintendent is required for the project. Typically required when this contractor is the Prime Contractor.

- A. The Plumbing Contractor shall have in charge of work at all times during construction, a competent foreman or superintendent whose experience and background shall qualify him for the work to be performed under this division. Once assigned, the foreman or superintendent shall be retained until completion of the project and any consideration as to his removal on grounds of incompetence shall either be initiated by or referred to the Design Professional for decision. Contractor is to provide a resume for the superintendent/foreman with prior approval by the owner.

1.13 CODES AND PERMITS

- A. All equipment, materials, and installation shall comply with the National Fire Protection Association's "National Fire Codes" and "National Electrical Code". Equipment shall bear the "UL" label as required by these codes.
- B. Install work in full accordance with rules and regulations of State, County and City authorities having jurisdiction over premises. This shall include safety requirements of Ohio State Department of Industrial Relations. Do not construe this as relieving Contractor from compliance with any requirements of specifications which are in excess of Code requirements and not in conflict therewith. Sanitary and waste piping indicated may, in some cases, exceed code requirements. If drawings indicate individual wastes for each fixture, the drawings shall hold precedent over the Code as long as the pipe sizing equals or exceeds prescribed waste and vent Code minimums.
- C. To comply with "Reduction of Lead in Drinking Water Act" all pipe, fixtures, and fitting used to convey water for potable use shall contain less than 0.25% of lead by weight.
- D. Unless otherwise indicated, secure and pay for all permits and certificates of inspection incidental to this work required by foregoing authorities. Be responsible for payments to all public utilities for work performed by them in connection with provision of service connections required under this DIVISION of specifications. Deliver all certificates to Design Professional in duplicate.
- E. The contractor shall be required to comply with OSHA requirement for physical hazards, safety equipment, fire fighting equipment and protective equipment.
- F. Belt guards, coupling guards, rails, roof fall protection, etc. shall be provided to meet OSHA requirements. Vent shafts and vertical openings shall be enclosed and comply with all OSHA requirements.

1.14 INTERFERENCES

- A. Before installing any work, this Contractor shall see that it does not interfere with clearance required for finish on beams, columns, pilasters, walls or other structural or architectural members, as shown on Architectural Drawings. If any work is so installed and it later develops that Architectural design cannot be followed, Contractor shall, at his own expense, make such

changes in his work as the Design Professional may direct to permit completion of Architectural work in accordance with plans and specifications.

- B. Install additional offsets on piping where required to obtain maximum headroom or to avoid conflict with other work without additional cost to the Owner. Where mounting heights are not detailed or dimensioned, install plumbing services and overhead equipment to provide the maximum headroom possible.
- C. Report any interferences between work under this division and that of any other Contractors to the Design Professional as soon as they are discovered. The Design Professional will determine which equipment shall be relocated, regardless of which was first installed, and his decision shall be final.

1.15 SHOP AREAS AND MATERIAL STORAGE

- A. No plumbing related trade is permitted to use as shop working area, any concrete slab that is to receive metallic waterproofing, asphalt tile, plastic tile, etc., except by express permission of the Design Professional.
- B. The Contractor shall make provisions for the delivery and safe storage of his materials and equipment in coordination with the work of others. Materials and equipment shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected. The arrival and placing of large equipment items shall be scheduled early enough to permit entry and setting when there is no restriction or problem due to size and weight. Stored piping and equipment to be covered and sealed at all open ends.

1.16 CLEAN-UP

- A. Refer to the Division 01 for general requirements for project cleaning. Contractor is responsible for cleaning each day.
- B. Insofar as the Plumbing work is concerned, at all times keep premises and building in neat and orderly condition, follow explicitly any instructions of Design Professional in regard to storing of materials, protective measures, cleaning-up of debris, etc.
- C. Upon completion of work, this Contractor shall thoroughly clean all apparatus furnished by him, pack all valves and thoroughly clean piping, fixtures and equipment removing all dirt, grease and oil.
- D. All equipment to be thoroughly cleaned prior to startup.

1.17 OPERATING AND MAINTENANCE

- A. This Contractor shall furnish competent personal instruction to the Owner's operating personnel for a period of hours as indicated in individual Division 22 specification sections in the proper operation of the plumbing equipment. He shall also supply the Owner with three (1) hardbound copies of an operation manual bound in a transparent vinyl sleeve on the front of the binder and

binder edge to protect labeling and (1) electronic copy in “PDF” format on disk. The manual shall be labeled on the front as well as the binder with the project name, project number, and the trade covered (i.e. “Plumbing”). The operating and maintenance manual shall include the following:

1. Cover sheet with project name, number, and contractor.
2. Contractor and sub-contractor contact and phone list.
3. Contractor warranty, indicating date of final acceptance and expiration.
4. Equipment and material warranties and guarantees.
5. Contact names and phone numbers for each product.
6. Table of contents.
7. Tabbed sections for each topic included in the manual.
8. Complete equipment list with model and serial number.
9. Manuals shall indicate all local suppliers of equipment.
10. Step-by-step procedures for start-up and shutdown for each system and piece of equipment.
11. Performance data, curves, ratings.
12. Wiring diagrams.
13. Manufacturer's descriptive literature.
14. Automatic controls with diagrams and written sequence of operation.
15. Manufacturer's maintenance and service manuals.
16. Spare parts and replacement parts list for each piece of equipment.
17. Name of service agency and installer complete with an emergency service phone number for nights, weekends and holidays.
18. Final approved shop drawings indicating actual device/equipment provided, not generic product data.
19. Final approved balance reports.
20. Final Operating parameters (Pressures, GPM etc.) Parameters must match TAB and Commissioning reports.

1.18 WARRANTIES

- A. Refer to the Division 01 Section: Specific Warranties for procedures and submittal requirements for warranties. Refer to individual equipment specifications for additional warranty requirements.
- B. Furnish to owner two (2) hard copies and (1) electronic in “PDF” format along with contact names, phone numbers, and email address for each product.
- C. This Contractor shall warranty all materials, workmanship and the successful operation of all equipment and apparatus installed by him for a period of one year from the date of the final acceptance of the entire work and shall guarantee to repair or replace at his own expense any part of the apparatus which may show defect during that time provided such defect is, in the opinion of the Design Professional, due to imperfect material or workmanship and not to carelessness or improper use. Compile and assemble the warranties specified in Division 22 into a separated set of vinyl covered three-ring binders, tabulated and indexed for easy reference.

1.19 TEMPORARY SERVICES

Elaborate on temporary services in Division 01, not this section. Make sure to cover utility charges in Division 01. Review the use of permanent equipment with Owner.

- A. The Contractor under this division shall provide temporary services, i.e.: water, fuel, sanitary, or storm as specified herein or in Division 01 "General Conditions" and "Special Conditions" portions of this specification.
- B. Permanent equipment may be used for temporary (construction period) services only as directed by the Design Professional. Any permanent equipment used, shall be maintained by this Contractor. Owner's warrantee period shall not begin until final acceptance of the completed system.

1.20 PROTECTION OF WORK AND PROPERTY

- A. The Contractor shall be responsible for safeguarding work, property and facilities against damage, both his own as well as others, with which he may come into contact in the performance of his work.
- B. Stored materials shall be protected against damage from weather. Pipe openings shall be closed with caps or plugs during installation. All fixtures and equipment shall be covered and protected against injury. Any materials or equipment damaged at any stage in the construction shall be replaced or repaired, and at the final completion of all work shall be in a clean, unblemished condition.

1.21 CUTTING AND PATCHING

Retain paragraph below only if Division 01 is included in the project.

- A. Refer to the Division 01 Section: CUTTING AND PATCHING for general requirements for cutting and patching.
- B. Do not endanger or damage installed Work through procedures and processes of cutting and patching. Arrange for repairs required to restore other work, because of damage caused as a result of plumbing installations. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

If Division 01 is used, coordinate if Division 22 Contractors are to do their own cutting and patching with Architect. Usually, Division 22 cut and patch should be by the Division 22 Contractors.

- C. The contractor under this division shall perform cutting, fitting, and patching of building components and plumbing equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work;
 - 2. Remove and replace defective Work;
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents;
 - 4. Remove samples of installed Work as specified for testing;
 - 5. Install equipment and materials in existing structures;

- 6. Upon written instructions from the Design Professional, uncover and restore Work to provide for Design Professional observation of concealed Work.
- D. See other sections of this specification for demolition requirements.
- E. Pipe holes in floors and walls shall be core drilled if not sleeved during construction.

Retain below only if it is applicable to the project.

1.22 INTERRUPTION OF SERVICE

- A. When work progress makes temporary shutdown of services unavoidable, shutdown shall be coordinated with and approved by Owner so as to cause minimum disruption to established operating routine. Arrange to work as necessary to re-establish service within shortest possible down time. In those instances where the length of time required for the service interruption is not acceptable to the Owner, unless otherwise indicated, furnish and install temporary connections as required to reduce the length of time of service interruption to an acceptable level. Provide advanced notification a minimum one week in advance for approval.

Retain below only if it is applicable to the project. Coordinate LEED points and reference numbers.

1.23 LEED DOCUMENTATION

- A. Contractor to refer to LEED IEQ C4.1 & C4.2 Low-Emitting Materials. Provide submittals showing compliance as follows:
 - 1. Product Data for Credit IEQ 4.1: For adhesives and sealants used, documentation including printed statement of VOC content. Refer to Division 01 Section "Sustainable Design Requirements" for additional procedures governing sustainable design.
 - 2. Product Data for Credit IEQ 4.2: For paints and coatings used, documentation including printed statement of VOC content. Refer to Division 01 Section "Sustainable Design Requirements" for additional procedures governing sustainable design.

PART 2 - PRODUCTS (Not Applicable to this Section)

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.3 TESTS AND ADJUSTMENTS

- A. Upon completion of the erection of all equipment and all work specified herein and/or shown on approved drawings, or at such times as directed by the Design Professional, this Contractor shall start all apparatus, make necessary tests as directed and as specified herein and make complete adjustments of all items of equipment before acceptance by the Design Professional to whose representative this Contractor shall demonstrate (by performance) all of the various apparatus and equipment.
- B. When the Contractor is ready to run capacity tests, he shall notify the Design Professional. When this notice is given, the Design Professional will assume that the Contractor has made preliminary tests and is satisfied that the plant will develop specified and guaranteed capacities. It will be the Contractor's responsibility to furnish any and all instruments required to obtain test data which shall include thermometers, electric meters, pressure gages, etc.

- C. Work under this division of the specifications shall not be considered complete until the Contractor has obtained required inspection, performance tests, made necessary adjustments and has submitted satisfactory evidence of compliance. The Design Professional or his representative will make spot checks to determine the accuracy and completeness of final adjustments. Should spot checks indicate more than a reasonable deviation from design requirements, the Contractor shall repeat tests and adjustments to the satisfaction of the Design Professional.

3.4 PUNCHLISTS

- A. From time to time throughout the course of the work, or upon completion of the work the Design Professional may perform site observations resulting in written documentation of deviations in the work from the Contract Documents. In such cases the Contractor shall respond in writing to each and every item on this written documentation stating the specific action taken to remedy the deviation. A response shall be provided by the Contractor for each separate observation. This work shall not be considered complete until such satisfactory written response is received by the Design Professional.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Each shop drawing is to be labeled with include KSU-Project Number, building or structure name, specification section, nameplate data, model number and efficiency rating along with full load amps for all electrical motors.
- C. Maintenance Manuals:
 - 1. One (1) preliminary review maintenance manual shall be submitted to OUA for review after the Associate has reviewed and approved and this shall be submitted prior to equipment start-up and function testing under the commissioning of the mechanical, electrical, plumbing or fire protection systems. Upon approval by the University and at the completion of the commissioning one (1) final hard copy and one (1) electronic copy on DVD or flash drive in "PDF" (searchable PDF format is required for all possible content or at minimum section dividers of content) format shall be provided at time of signing your contract completion certificates and shall be uploaded into the OAKSCI (if applicable) at that time and the electronic copy is to be provided to OUA prior to release of project retainage.
 - 2. Maintenance manuals shall include at a minimum the following in addition to that specified earlier:
 - a. Cover sheet with project name, KSU project number, Associate names and prime contractors involved.
 - b. All equipment start-up reports.
 - c. All local suppliers and contact information for supplied equipment and components.
 - d. Equipment and material warranties and guarantees. Provide also in an electronic list in Excel spreadsheet format.
 - e. Final State Inspection sign off forms with associated CPA numbers.

- f. Training Forms.
 - g. CxA commissioning forms when applicable to project.
 - h. All final submittals shall indicate **actual device provided** not general product information. Clearly indicate all options provided. Submittals to include the Project Name, KSU Project Number, Specification Section, Associated Tag Number if applicable, referenced or drawing number if calling out product.
- D. Draining or Chemical Cleaning of any Closed Loop Chilled Water, Steam and Steam Condensate Systems, Glycol Systems, Closed Loop Heating Water, and Cooling Tower Water Systems to the City of Kent's sanitary system is prohibited, without filling for a discharge drainage permit. Mandatory two week notice to dump will be required with an approved signed document from the City of Kent. KSU submits required forms to city, however contractor must provide onsite personnel contact information and estimated volume of discharge that will be drained. KSU would prefer that the designing engineers require reclaim methods be implemented versus dumping, unless no other options are possible. Compliance with these requirements will be required in your base of design for any project on the Kent Campus.

END OF SECTION 220500

SECTION 22 05 01 - BASIC MECHANICAL MATERIALS AND METHODS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.
- B. Requirements specified in Division 22 Section "Common Work Results for Plumbing" apply to this section.
- C. Requirements of Division 03 specification sections apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of plumbing related work required by this section is indicated on drawings and/or specified in other Division 22 sections.

Retain below if applicable. Coordinate excavation and backfilling with the Architect. Use Paragraph "B" if this contractor is to perform (preferred) or "C" if by the general contractor.

- B. Except as noted in this specification, this Contractor shall do all excavating and backfilling necessary to the work of this Division.
- C. This Contractor is to coordinate all excavating and backfilling required under this Division with General Trades as specified under Division 03.
- D. See specification Division 09 for painting requirements. Coordinate all plumbing painting work required. Coordinate protection requirements for plumbing equipment which could be damaged by paint.

Retain above if Architect is specifying painting, otherwise use paragraph below.

- E. This Contractor shall perform all painting incidental to this work.
- F. Furnish and install all miscellaneous steel required for supports, hangers, anchors, guides, etc., required for installation of equipment and materials furnished and installed under this Division. Steel used in a moist environment shall be hot dipped galvanized unless otherwise noted.

Coordinate concrete requirements with Architect. Select one of the following two paragraphs.

- G. This Contractor shall furnish and install concrete foundations or bases under all equipment that rests on floors in Mechanical Equipment Rooms. Follow drawings and/or manufacturer's literature with regard to design and construction of same.
- H. This Contractor shall provide to the General Trades Contractor dimensions and special requirements for the concrete foundations or bases under all equipment that rests on floors in Mechanical Equipment Rooms. Follow drawings and/or manufacturer's literature with regard to design and construction of same.

Review with Owner and edit accordingly.

- I. This Contractor shall perform all Division 22 related and indicated selective demolition including nondestructive removal of materials and equipment for re-use or salvage as indicated. Unless otherwise indicated, dismantle plumbing materials and equipment made obsolete by these installations. All equipment removed shall be offered to the Owner for his retention. If the Owner elects to retain equipment, it shall be turned over to the Owner at the site. If not, the equipment shall be removed from the premises by this Contractor.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. Concrete Work Codes and Standards: Comply with governing regulations and, where not otherwise indicated, comply with industry standard, in its application to work in each instance.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including the recommended installation method, all in accordance with Division 01 and Section 220500 requirements.

PART 2 - PRODUCTS**Retain below only if this contractor is responsible for concrete work.****2.1 MATERIALS OF DIVISION 22 CONCRETE WORK**

- A. Reinforcing Materials:
 1. Reinforcing Bars: Except as otherwise indicated, provide ASTM A 615, deformed, Grade 40 for size numbers 3 through 18; ASTM A 675, plain, Grade 60, for size number 2; sizes as indicated or required.
- B. Reinforcement Supports: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Provide wire bar type supports complying with CRSI recommendations, unless otherwise indicated.
- C. Concrete Materials:
 1. Portland Cement: ASTM C 150, Type I, except as otherwise indicated.
 2. Aggregates: ASTM C 33, except as otherwise indicated.

- a. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used.
 - b. For rough grouting, provide aggregate which is well graded and 100 percent passing through 3/8" sieve.
3. Water: Clean and free of substances harmful to concrete.

2.2 DESIGN AND PROPORTIONING OF CONCRETE MIXES

- A. General: Design plumbing work concrete as follows, for each 28-day compressive strength class:

Select 4000 psi for supporting large tanks or for beams, 3000 psi for equipment pads and foundations, 2550 psi for filling inertia bases, backfill class for rough backfilling with concrete.

1. 4000 psi Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.35 water/cement ratio.
2. 3000 psi Class: 500 lbs of cement per cu. yd. (5.25 sacks), and 0.46 water/cement ratio.
3. 2500 psi Class: 450 lbs. of cement per cu. yd. (4.75 sacks), and 0.54 water/cement ratio.
4. Backfill Class (Lean Concrete): 375 lbs of cement per cu. yd., (4.0 sacks), and 0.60 water/cement ratio.
5. Rough Grouting Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.60 water/cement ratio.

- B. Mix for Patching: Where plumbing work requires patching of exposed concrete work which has been cut to accommodate plumbing work, provide concrete patching mix which is identical with mix of work being patched (same cement, aggregates, admixtures and proportioning).

Retain below if excavation is required by this contractor.

2.3 EXCAVATING FOR DIVISION 22 WORK:

- A. Backfill Materials:

1. All backfilling within the building shall consist of an initial 12" layer of sand over the pipe. The remainder of the backfill shall be course interlocking aggregate or limestone screenings.
2. All backfilling outside the building shall be interlocking limestone aggregate or limestone screenings.

Include this section below only if plumbing is to provide painting.

2.4 GENERAL DIVISION 22 PAINTING PRODUCT REQUIREMENTS:

- A. All exposed insulation in occupied areas (and elsewhere, as indicated) shall be painted at the time of installation with one coat of water base paint. At the completion of the work all such insulation shall be given an additional coat of alkyd resin paint of a color to match existing building structure, or as selected by the Architect/Engineer.

- B. All uncovered ferrous pipe, fittings, exposed threads of galvanized pipe, non-factory painted portions of valves, hangers, structural steel, expansion tanks, and all other ferrous work shall be thoroughly cleaned and given two coats of alkyd resin paint of a color as selected by the Architect/Engineer.
- C. All general equipment and materials so indicated on the drawings as work to be painted by this contractor shall be thoroughly cleaned and given two (2) coats of a color as selected by the Architect/Engineer.
- D. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - Devoe and Reynolds Co. (Devoe).
 - Glidden Coatings and Resins, Div. of SCM Corporation (Glidden).
 - Benjamin Moore and Co. (Moore).
 - PPG Industries, Pittsburgh Paints (Pittsburgh).
 - Pratt and Lambert (P & L).
 - The Sherwin-Williams Company (S-W).

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS, EXCAVATION AND BACKFILL FOR DIV. 22 WORK:

Coordinate below with Architect for Division 02.

- A. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during excavation operations.
- B. Notify proper authorities prior to commencing excavation. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

Delete below if no existing utilities.

- C. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Architect/Engineer and then only after acceptable temporary utility services have been provided.
 - 1. Provide minimum of 48-hour notice to Architect/Engineer, and receive written notice to proceed before interrupting any utility.

Edit above to suit project requirements.

- D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

- E. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights. Where trenches cross roads, walks, or public thoroughfares, provide suitable barricades and bridges adequately protected by signs or red flags during day and lights at night.
- F. Operate warning lights as recommended by authorities having jurisdiction.
- G. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
 - 1. Perform excavation within drip-line of large trees to remain by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.
- H. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install plumbing work on frozen excavation bases or subbases.

3.2 EXCAVATING FOR DIVISION 22 WORK:

- A. General: Do not excavate for plumbing work until work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum.
- B. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
- C. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- D. Deep Excavation Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
- E. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.
- F. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
- G. Dewatering: Lay no pipe in water. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
- H. Do not allow water to accumulate in excavations. Remove water to prevent soil changes detrimental to stability of subgrades. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
- I. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

- J. Excavation for Pavements: Cut surface under pavements as required. Repave all streets or sidewalks disturbed at this Contractor's expense, to recommendations, procedures and satisfaction of the Architect/Engineer and authorities having jurisdiction.
- K. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe.
- L. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups. Any trenches dug below required depth shall be filled to proper depth with sand.
- M. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
- N. For pipes 5" or less in nominal size, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
- O. For pipes or conduit 6" or larger in nominal size, tanks and other plumbing work indicated to receive subbase, excavate to subbase depth indicated, or, if not otherwise indicated, to 6" below bottom of work to be supported.
- P. Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam, condensate, drainage) so top of piping is not less than 3'-6" below finished grade.

3.3 PREPARATION OF FOUNDATION FOR BURIED PIPING:

- A. Grade trench bottom to provide smooth, firm, stable, and rock-free foundation throughout length of piping.
- B. Remove unstable, soft, and unsuitable materials at surface on which piping is to be laid, and backfill with clean material as specified.
- C. Shape bottom of trench to fit bottom of piping. Fill unevenness with tamped-sand backfill. Dig bell holes at each pipe joint to relieve bells of loads and to ensure continuous bearing of pipe barrel on foundation.
- D. Care shall be exercised to keep interior of buried piping free of dirt and foreign matter.

3.4 BACKFILLING:

- A. Backfill with finely-graded subbase material to 6" above wrapped, coated, and plastic piping and tanks, and to centerline of other tanks.
- B. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.
- C. Backfill simultaneously on opposite sides of plumbing work, and compact simultaneously; do not dislocate work from installed positions.

- D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (% of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.
1. Lawn and Landscaped Areas: 85% of cohesive soils; 90% for cohesionless soils.
 2. Paved Areas, Other Than Road ways: 90% for cohesive soils; 95% for cohesionless soils.
 3. Roadways: 90% for cohesive soils; 95% for cohesionless soils.
- E. Backfill to elevations matching adjacent grades, at time of backfilling excavations for plumbing work.

3.5 DISPOSAL OF EXCESS AND WASTE EXCAVATION MATERIALS:

- A. Removal from Owner's Property: Remove excess excavated material, trash, debris and waste materials and dispose of it off Owner's property.

3.6 INSTALLATION OF CONCRETE WORK

Coordinate concrete work in this section with Division 03 Section "Cast-In-Place Concrete" or "Miscellaneous Cast-In-Place Concrete."

Retain below when seismic restraints are required. Coordinate below with Division 22 Sections specifying equipment. Indicate dowel rod quantity, size, and spacing on drawings.

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions [**and according to seismic codes at Project**].
- B. Formwork:
1. General: Design, construct and maintain formwork to support vertical and lateral loads including pressure of cast-in-place concrete. Construct formwork so that formed concrete will be required size and shape and in required location. Construct with joints which will not leak cement paste. Form sides and bottoms of concrete work, except where clearly indicated to be cast directly in excavation or against other construction, or on grade or prepared subgrade. Design and construct forms for easy removal without damage to concrete and other work.
 - a. Install chamfer strips at external corners of exposed concrete work.
 - b. Construct forms to retain equipment anchor bolts in accurate locations during placement of reinforcing steel and concrete. Use templates furnished by equipment manufacturers to locate anchor bolts or, where not furnished, locate by accurate measure from certified setting diagrams.
- C. Placing Reinforcement:
1. General: Comply with requirements and recommendations of specified standards, including "Placing Reinforcing Bars" by CRSI. Place bars where indicated and support to

prevent displacement during concrete placement, using appropriate reinforcement supports, properly spaced and wire tied to reinforcing bars.

- a. Place reinforcement to obtain at least minimum recommended coverages for concrete protection. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which would reduce bond with concrete.

D. Placing Concrete:

1. Wet wooden forms which have been coated with compound, immediately before concrete, and remove excess water from forms.
2. Strength-Class Application: Comply with the following general application requirements.
 - a. Backfill: Provide backfill class (lean concrete).
 - b. Underground Structural Concrete: Provide 3000 PSI class.
 - c. Block-Type Foundations: Where least dimension is not less than 0.2 x largest dimension, provide 3000 PSI class.
 - d. Beam-Type Foundations: Where least dimension is less than 0.2 x largest dimension, provide 4000 PSI class.
 - e. Miscellaneous Supported Work: Provide 3000 PSI class for curbs, pads, and similar supported work.
 - f. Concrete Fill: Provide 2500 PSI class for filling structural steel foundation frames and for filling similar large-volume units.
 - g. Concrete Grout: Provide rough grouting class for filling voids to be grouted which are too small to be filled effectively with 2500 PSI class concrete.
 - h. Patching General Concrete Work: Match concrete being patched.
3. Deposit concrete continuously or in layers of thickness which will result in no concrete being placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within section. If section cannot be placed continuously, provide construction joints. Deposit concrete as nearly as practicable in its final location, so as to avoid segregation due to rehandling or flowing.
4. Consolidate placed concrete by plumbing vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures complying with recommended practices of ACI 309; eliminate voids in work.
5. Cold Weather Placement: Comply with ACI 306. Do not use frozen materials or materials containing ice and snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. When air temperature has fallen or is expected to fall below 40 deg F (4.4 deg C), heat water and aggregates uniformly before mixing, as required to obtain concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (26.7 deg C), at time of placement. Protect concrete work from physical damage and reduced strength resulting from frost, freezing actions, or low temperatures.
6. Finishing Horizontal Surfaces: Float and trowel horizontal (top) surfaces to level, smooth, uniform textured, dense finish, where surface is to remain exposed or receive coating, membrane or other thin-set finish. Otherwise, leave struck-off surface undisturbed; except

scratch surfaces which are to receive concrete or mortar topping or setting bed, by raking with a stiff broom.

7. Depress top of concrete backfill sufficiently so that supported work can be set in bed of mortar or sand as indicated.
8. Curbs: Provide monolithic finish on interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to hard, dense finish with corners, intersections and terminations slightly rounded and coved.
9. Surface Repairs:
 - a. Unexposed Surfaces: Repair significantly damaged and honeycombed areas, and remove major projections and fins where forms have been removed.
 - b. Exposed Surfaces: On formed surfaces which are to be exposed, including those to be coated or covered with membrane or other thin-set applied finish, repair and patch form-tie holes and damaged and honeycombed areas, filling voids with grout and completely removing fins and other projections.

E. Concrete Curing and Protection;

1. General: Protect freshly placed concrete from drying and excessively cold and hot temperatures, and maintain in moist condition at relatively constant temperature for period of time necessary for hydration of cement, proper hardening, and achievement of strength requirements as specified.

F. Miscellaneous Concrete Work:

1. Concrete Grouting:
 - a. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
 - b. Clean surfaces that will come into contact with grout.
 - c. Provide forms as required for placement of grout.
 - d. Avoid air entrapment during placement of grout.
 - e. Space approximately 1" thick between bottom of equipment and top of concrete foundation or base which remains after shimming, shall be filled completely with grouting. Grout shall be made up with sand and cement designed for the purpose which does not shrink on setting up.
 - f. Grout openings and recesses as indicated, in and around plumbing work and other work which penetrates or adjoins plumbing concrete work, using rough grouting class of concrete mix.
 - g. Provide formwork where required, and tamp, screed and trowel surfaces.
 - h. Place grout on concrete bases and provide smooth bearing surface for equipment.
 - i. Place grout around anchors.
 - j. Exposed surface of grouting shall be finished to make a neat appearance.
 - k. Cure grout as specified for concrete work.
2. Concrete Bases: In the absence of more specific information, either on drawings, or manufacturer's literature, the bases shall be level, shall have a minimum height above finished floor of 4" and extend 3" beyond the skids, feet or bed plate of the item of equipment.

3. Concrete pads, beams, pedestals, or saddles placed in existing structures shall be mounted securely to the original substrate with anchor bolts.
- G. General Concrete Clean-Up: Upon completion of concrete work, clean excess concrete from adjacent areas and surfaces. Remove excess concrete by proper methods of washing or scraping, using care not to scratch or otherwise damage finished surfaces.

3.7 SURFACE PREPARATION FOR PAINTING:

- A. General: Clean surfaces before applying paint products. Remove oil and grease prior to mechanical cleaning. Comply with paint products manufacturer's instructions for surface cleaning and preparation. Remove surface-applied accessories which are not to be painted, and reinstall after completion of painting. Protect non-removable items not to be painted, by covering with paper or plastic film.
- B. Ferrous Metal Surfaces: Clean and remove mill scale and loose rust on surfaces which are not zinc-coated or shop/factory prime coated.
- C. Zinc-Coated Surfaces: Clean with non-petroleum based solvent. Wash with copper sulfate solution and flush with water, unless surface has been pretreated, or unless treatment is not recommended by manufacturer of prime coat.

3.8 PAINT SYSTEM APPLICATION:

- A. Environmental Conditions, Painting Work: Comply with governing regulations concerning use of and conditions for application of paint. Comply with manufacturer's recommendations and instructions. Do not apply paint in unfavorable conditions of temperature, moisture (including humidity) or ambient contamination (dust and other pollutants).
- B. Mixing: Comply with manufacturer's recommendations for mixing or stirring paint products immediately before application.
- C. Application Limitations: Except as otherwise indicated, paint every accessible surface of each unit of work indicated to be painted, regardless of whether in location recognized as "concealed" or "exposed".

Delete from and insert into the following list of omissions to satisfy project requirements.

1. Omit painting on surfaces located in service shafts and above non-removable ceilings and in similar places where in the opinion of the Engineer, space is too limited or services are too congested to allow access for painting.
2. Omit painting on machined sliding surfaces and rotating shafts of equipment, and on nonferrous finished metals including chrome plate, stainless steel, special anodized aluminum, brass/bronze and copper, and on plastics and similar finished materials, except where specifically indicated to be color-coded by painting.

3. Omit painting on required name plates, labels, identification tags, signs, markers, printed instructions, performance ratings, flow diagrams and similar text and graphics, located within the scope of work indicated to receive paint application.
 4. Omit specified prime coat of paint system for metal surfaces where surface has shop-applied prime coat of equivalent quality. Apply prime coat on other surfaces to be painted; comply with paint manufacturer's instructions for prime coating where not otherwise indicated. Apply additional prime coats where suction spots or unsealed areas appear.
- D. General Application Requirements: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate, for type of material being applied, and for ambient conditions. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Apply paint at edges, corners, joints, welds and exposed fasteners in manner which will ensure dry-film thickness equal to that of flat surfaces. Allow sufficient time between successive coats for proper drying (comply with manufacturer's drying instructions).
1. Number of Coats: Number indicated is minimum number; apply as many coats as are necessary to comply with dry-film thickness requirements.
 2. Coating Thickness: Apply uniform coats to produce dry-film thickness indicated or, if not otherwise indicated, apply paint without thinning in application thickness recommended by manufacturer for each coat.
 3. Smooth Finishes: Except as otherwise indicated, apply paint in smooth finish without noticeable texture, cloudiness, spotting, holidays, laps, brush marks, runs, sags, ripples, ropiness and other surface imperfections.
 4. Textured Finishes: Where indicated, roll and redistribute paint of final coat to even texture. Match adjoining texture paint finishes if any, and roll to eliminate evidence of roller or lap marks and other unevenness and imperfections.

3.9 PAINING CLEAN-UP AND PROTECTION:

- A. General Painting Clean-Up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day. When directed by Architect/Engineer, retain paint containers from application of coatings on particular unit or area of work, until average dry-film thickness has been calculated.

Delete below if final cleaning is not done by painter. This may be the general contractor's responsibility.

1. Spattered Surfaces: Upon completion of painting work, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.
2. Protection: Protect work of other trades, whether to be painted or not, against damage by painting work. Correct damage by cleaning, repairing or replacing and repainting as directed. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings installed for protection of work not to be painted, after completion of painting operations. At

completion of work by other trades, touch-up and restore damaged or defaced painted surfaces.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

Retain below if relevant.

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

Delete below when demolition and / or reference to Division 01 is not included in the project.

3.12 SELECTIVE DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching".
- B. Refer to Division 01 Specifications for outline of recycling and salvaging materials, procedures, and overall diversion goals for demolition.
- C. General: demolish, remove, demount, and disconnect abandoned plumbing materials and equipment indicated to be removed and not indicated to be salvaged or saved. Remove associated hangers, supports, miscellaneous steel. Disturbed remaining insulation to be repaired to match existing with vapor barrier.
- D. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
- E. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
- F. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- G. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- H. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

- I. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- J. Where walls are removed and sleeves are left on plumbing piping, remove the sleeves and associated insulation and install new insulation.
- K. Demolition of Refrigerant-Containing Equipment and Piping:
 - 1. Demolish, remove and disconnect refrigerant-containing equipment and piping as indicated and required. Prior to such work, recover without venting all refrigerant in compliance with Environmental Protection Agency (EPA) Rule 40 CFR Part 80. Recovery shall be performed by certified technicians in accordance with that rule. After recovery, the Contractor shall advise the Owner of the amount of refrigerant recovered and the Owner shall advise the Contractor whether he wishes to recycle or reclaim the refrigerant. If so, the Contractor shall turn the recovered refrigerant over to the Owner at the construction site in approved, sealed containers for recycling at the Owner's expense. If the Owner does not wish to retain the refrigerant, the Contractor shall remove and legally dispose of all refrigerant.
 - 2. Provide Owner with certification of recovery and disposal of refrigerant. This includes documentation of refrigerant type, charge pressure, reclaim amount, and method for disposal.
- L. Exposed piping indicated to be removed back to the active line and capped.
- M. Protect adjacent materials indicated to remain.
- N. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
- O. Locate, identify, and protect plumbing services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- P. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing plumbing materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for relocation or storage.
- Q. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- R. Plumbing Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, supports, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.
 - a. Unless otherwise indicated, piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

2. Perform cutting and patching required for demolition in accordance with requirements of other sections of this specification.

S. The use of explosives in this work is prohibited.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Backfill and Fill Material: Backfill requirements at road and parking lot crossings shall meet the City of Kent's standards for backfilling. City of Kent's approval is not required unless work is within the public right of way or the utility is owned by the city. Review with OUA if any questions.
- C. Miscellaneous Metals: All outdoor miscellaneous metal equipment supports shall be galvanized steel. Spray-on galvanizing shall be applied to all disturbed areas. All indoor miscellaneous metal equipment supports shall be black iron, primed and painted or galvanized.
- D. All materials shall be non-asbestos containing.
- E. All firestop material shall be painted to match adjacent wall surfaces in visible public spaces.
- F. Obtain welding permit from KSU OUA.

END OF SECTION 220501

KSU DESIGNERS NOTES:

1. Wherever possible, abandoned piping shall be removed back to the main and capped

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings, and further described in other specification sections.

1.3 SUBMITTALS

- A. Submit product data for motors and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections. Submit compliance to referenced standards and efficiencies.
- B. Free standing motors and other electrical components not submitted under other sections shall require separate submittal.
- C. Submit manufacturer's electrical requirements for power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

1.4 QUALITY ASSURANCE

- A. National Electrical Manufacturer's Association (NEMA) Standards MG 1: Motors and Generators, "Energy Efficient Design".
- B. NEMA Standard 250: Enclosures for Electrical Equipment
- C. Comply with National Electrical Code (NFPA 70). Provide motors specified in this section that are "Listed and Labeled" as defined in Article 100.

1.5 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
1. Motor controllers.
 2. Torque, speed, and horsepower requirements of the load.
 3. Ratings and characteristics of supply circuit and required control sequence.
 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Baldor
 2. General Electric
 3. Lincoln
 4. Allis-Chalmers
 5. Reliance Electric
 6. WEG
- B. Comply with NEMA MG 1 unless otherwise indicated.

Retain option below for severe duty motors.

- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
1. Motors ½ HP and Larger: Polyphase.
 2. Motors Smaller than ½ HP: Single phase.
 3. Frequency Rating: 60 Hz.
 4. Voltage Rating: Determined by voltage of circuit to which motor is connected.
 5. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.
 6. Temperature Rise: Match insulation rating, unless otherwise indicated.
 7. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
 8. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

9. Enclosure Type: Shall be open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, guarded drip-proof motors where exposed to contact by employees or building occupants, and weather protected Type I for outdoor use, Type II where not housed.
10. Overload Protection: Built-in thermal overload protection rated at 115% of full load motor and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
11. Efficiency: Motors shall have a minimum efficiency as scheduled in accordance with NEMA Standard MG-1, most current table for high efficiency motors. Motors must meet or exceed the guaranteed minimum of this standard and shall be nameplated with the nominal value.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage, unless otherwise indicated.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating, unless otherwise indicated.
- I. Insulation: Class F.
- J. Code Letter Designation:
 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Provide with integral motor bearing current protection (AEGIS) rings.

Retain option below only if project requires severe duty motors based on environmental conditions

- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
- D. Source Quality Control: Perform the following routine tests according to NEMA MG 1:
1. Measurement of winding resistance.
 2. No-load readings of current and speed at rated voltage and frequency.
 3. Locked rotor current at rated frequency.
 4. High-potential test.
 5. Alignment.

2.5 SINGLE-PHASE MOTORS

- A. As indicated in equipment specification sections, or if not indicated as selected by manufacturer from one of the following to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split phase start, capacitor run.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Service Factor: 1.15.
- D. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading used on belt connected motors. Sealed, prelubricated sleeve bearings for other single-phase motors..
- E. Motors 1/20 HP and Smaller: Shaded-pole type.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range, unless otherwise noted.

PART 3 - EXECUTION (Not Applicable)

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 SHAFT GROUNDING RINGS (ALL MOTORS WITH VARIABLE FREQUENCY DRIVES)

- A. Shaft grounding rings (SGR) shall be factory installed inside the motors by the manufacturer wherever possible. SGR's may be field installed by installing contractor subject to Engineer's approval. Provide AEGIS SGR Colloidal Silver Shaft Coating, or approved equal, on shafts prior to rings installation, per SGR manufacturer's recommendations, after first cleaning shafts.
- B. Install and test SGR's in accordance with manufacturer's recommendations. Install the SGR so that the aluminum frame maintains an even clearance around the shaft. Conductive microfibers shall be in full circumferential contact with conductive metal surface of the shaft. Do not use thread lock to secure the mounting screws as it may compromise the conductive path to ground. If thread lock is required, use a small amount of EP2400 AEGIS Conductive Epoxy, or approved equal, to secure the screws in place.
- C. Shafts shall be clean and free of any coatings, paint, or other nonconductive material (clean to bare metal). Depending upon the condition of the shaft, it may require using emery cloth or Scotch-Brite. If the shaft is visibly clean, a non-petroleum based solvent may be used to remove any residue.
- D. Check the conductivity of the shaft using an ohm meter.
 - 1. Ohms test: Place the positive and negative meter leads on the shaft at a place where the microfibers will contact the shaft. Each motor will have a different reading but in general one should have a maximum reading of less than 2 ohms. If the reading is higher, clean the shaft again and retest.
- E. After motors with SGR are fully installed in the field (in equipment, assemblies, or individually), for both factory-installed-SGR and field-installed-SGR cases, test for a conductive path to ground using an Ohm meter.
 - 1. Place one probe on metal frame of SGR and one probe on motor frame.
 - 2. Motor must be grounded to common earth ground with variable frequency drive according to applicable standards.
 - 3. Verify that SGR installations and test readings comply with SGR manufacturer's requirements.
 - 4. Shaft voltage testing and verification of the proper installation of the AEGIS Bearing Protection Ring and its effectiveness can be accomplished by testing the motors for shaft voltages using a digital oscilloscope that is 100-Mhz or faster.
 - 5. An AEGIS Shaft Voltage Test Probe is attached to the oscilloscope probe end which is then placed on the machine's shaft allowing for the "real time" measurement of machines as they are operating under PWM IGBT VFD control.

4.2 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. PRODUCTS:
1. All electrical components shall be UL labeled.
 2. Noise Rating: Motors shall be of "premium" efficiency and shall exceed mandated government efficiencies. All motors shall employ bearings for a "quiet" noise rating.
 3. Efficiency: "Energy Efficient" motors shall be of premium efficiency as scheduled in accordance with IEEE Standard 112, test method "B".
- C. INSTALLATION:
1. All electrical installations shall comply with the Division 26 specifications and with the National Electric Code.

KSU DESIGNERS NOTES:**1. Motors:**

- a. 1/3 HP and below use 120V/1 Phase/60Hz. (Unless reviewed with KSU/OUA)
- b. 1/2 HP and above use 208, 230 or 460V/3 Phase/60HZ. (Unless reviewed with KSU/OUA)
- c. Associate to provide info on efficiency and motor types, nameplate data to OUA for review.
- d. Harmonics and lubrication shall be addressed. Motor brake HP, RLA, LRA shall be indicated on the drawing schedules.
- e. All motors shall have a minimum service factor of 1.15 and be designed for non-overloading use.
- f. Motors exposed to wet locations shall be TEFC or meet NEC requirements, whichever is more stringent.
- g. "AEGIS" Type Shaft grounding technology shall be applied to all motors driven by VFDs. This applies to pumps, fans, and other systems on VFD driven type of systems. Review other system if base of design is not around AEGIS.

END OF SECTION 220513

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.
5. Mechanical System Sound Stopping.
6. Mechanical System Penetration Seals.

- B. Related Requirements:

Leave Paragraph below if included in specifications

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 DESCRIPTION OF WORK

1. Furnish and install sound stopping around penetrations or mechanical materials and equipment.
2. Furnish and install fire and smoke penetration seals around penetrations of mechanical materials and equipment through fire or smoke barriers, floors and foundation walls.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Fire and Smoke Sealers: For each type of installation provide corresponding assembly detail complying with the current NFPA, ASTM E814, and by Underwriters Laboratory requirements.
- C. Mechanical System Penetration Seals (Firestopping): Submit the following:
 1. Shop drawings showing each condition requiring penetration seals in dictating proposed UL systems materials, anchorage, methods of installation, and actual adjacent construction.

2. A copy of UL illustration of each proposed system indicating manufacturer approved modifications.
3. Manufacturer's specifications, recommendations, installation instructions and maintenance instructions.
4. Tested firestop systems engineering judgement.

1.5 QUALITY ASSURANCE

- A. The firestopping systems are to be installed by experienced, manufacturer trained, and UL certified or FM certified personnel.
- B. All firestopping material is to be provided from a single manufacturer for all applications.
- C. Consult manufacturer's technical experts for assistance in selective appropriate firestop system for each application.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- D. Molded non-conductive, high impact resistant HDPE sleeves (for installations less than 150°F) similar to Proline CS – Century Line Sleeve or Westlantic Tech Corp Wall Sleeves WA. Provide with puddle flange (water stop ring) configuration for mechanical sleeve seal installations.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Flexicraft.
 4. Link-Seal / Thunderline Corp. / Garlock Piping Technology.
 5. Metraflex Company (The).
- B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
3. Sealing Elements: EPDM-rubber for systems up to 250°F interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size. Pressure plates to be composite plastic.
4. Sealing Elements: High-temperature-silicone for systems up to 400°F with interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size. Pressure plates to be coated carbon steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
6. Concrete Wall Penetrations: All concrete wall penetration sleeves shall have a puddle flange (water stop ring) configuration.

2.3 GROUT

- A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, mildew resistant, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer.
- B. Install sleeves accurately centered on pipe runs.
- C. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but no less than 2 pipe sizes larger than piping run.
- D. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for insulation installation.

- E. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 2" above level floor finish, 3/4" above floor finish sloped to drain, and flush with floor in other areas.
- F. Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves.
- G. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- H. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

Retain below if sleeves are not required for core-drilled holes.

- 1. Sleeves are not required for core-drilled holes.
- I. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

Retain below if sleeves are not required for holes in slabs formed by PE or PP molded sleeves.

- 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
- 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- 3. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.

Delete references to Division 07 if not applicable.

- J. Install sleeves for pipes passing through interior partitions and slabs as they are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
 - 4. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - 5. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - 6. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - a. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - b. Seal space outside of sleeve fittings with grout.
 - 7. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.
 - a. Refer to Division 07 Section "Joint Sealants" for materials and installation.

- K. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- L. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- M. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- L. Refer to Division 07 Section "Penetration Firestopping" for materials.**
- N. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials.

Leave Paragraph below if included in specifications

1. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building. Coordinate installation of sleeve prior to pouring walls so that water stop / sleeve assembly is within poured wall on new installations. If holes are core drilled through existing walls, mechanical sleeve seal shall seal up against cored hole.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls Above Grade:

- a. Piping Smaller Than NPS 6: Steel sleeves.
- b. Piping NPS 6 and Larger: Cast-iron pipe sleeves.

2. Exterior Concrete Walls Below Grade:

- a. Piping Smaller Than NPS 6: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- b. Piping NPS 6 and Larger: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

- a. Piping Smaller Than NPS 6: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- b. Piping NPS 6 and Larger: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs Above Grade:

- a. Piping Smaller Than NPS 6: Steel pipe sleeves.
- b. Piping NPS 6 and Larger: Steel pipe sleeves.

5. Interior Partitions:

- a. Piping Smaller Than NPS 6: Steel pipe sleeves.
- b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

3.5 PLUMBING SYSTEM SOUND STOPPING

- A. Where pipes or ducts or other components of Division 22 work pass through non-fire rated walls or floors, but walls which extend from horizontal structure to structure, provide sound stopping between such mechanical work and the building structure intended to reduce the transmission of sound from one side of the wall to the other.
- B. Sound stopping of pipes in sleeves shall consist of sealing the outside of the sleeve with caulking and the inside with an insulating material.
- C. Sound stopping of pipes or ducts without sleeves shall consist of packing the cavity around the penetration with an insulating material and sealing the opening with approved sealant or plaster.
- D. Insulating materials shall be non-asbestos and non-friable, and shall have a flame spread rating of no more than 25 and a smoke developed rating of no more than 50.

3.6 PLUMBING SYSTEM PENETRATION SEALS

- A. Where pipes or ducts or other components of Division 22 work pass through fire or smoke rated walls or floors, provide non-asbestos seal assemblies classified by UL to provide fire barriers equal to the time rating of the construction being penetrated, with materials that comply with applicable codes and that have been tested in accordance with UL 1479 or ASTM E-814.
- B. Install penetration seal materials in accordance with printed instructions of the UL Building Materials Directory and in accordance with manufacturer's instructions. Seal all holes or voids made by penetrations. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor.
- C. The contractor shall provide submittal data on each installation type for approval by the Associate.
- D. Fire and smoke sealing systems shall be tested in accordance with the appropriate current NFPA ASTM E 814 and by Underwriters Laboratories requirements.
- E. All materials shall be non-asbestos containing.
- F. All firestop material shall be painted to match adjacent wall surfaces in visible public spaces.
- G. Hold a pre-installation meeting with General associated trades and Owner. Review contractor inspection guidelines.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

- B. Standard sealant manufacturer colors shall be submitted to the Associate for selection, and to KSU OUA for approval. Sealant to be non-asbestos containing.
- C. All firestop material shall be painted to match adjacent wall surfaces in visible public spaces.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Escutcheons.
- 2. Floor plates.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel or brass with polished, chrome-plated finish and spring-clip fasteners.
- D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall:
 - 1) One-piece, deep pattern with spring-clip fasteners.
 - b. Chrome-Plated Piping:
 - 1) One-piece cast brass.
 - c. Insulated Piping:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - f. Bare Piping in Unfinished Service Spaces:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - g. Bare Piping in Equipment Rooms:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
 - 2. Escutcheons for Existing Piping to be split-plate, stamped steel with concealed hinge for the following:
 - a. Chrome-Plated Piping.
 - b. Insulated Piping.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces.
 - e. Bare Piping in Unfinished Service Spaces.
 - f. Bare Piping in Equipment Rooms.
 - 3. Escutcheon Finishes:
 - a. Furnish pipe escutcheons with chrome finish for occupied areas, prime paint finish for unoccupied areas.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with inside diameter to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 SUPPLEMENTAL REQUIREMENTS

- A. General: Provide pipe escutcheons on all pipes passing through floors and all pipes passing through walls or ceilings in exposed areas with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with chrome finish for occupied areas, prime paint finish for unoccupied areas.
- B. Pipe Escutcheons for Moist Areas including Equipment Rooms: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
- C. Pipe Escutcheons for Dry Areas: Provide chrome plated sheet steel escutcheons, solid or split hinged.
- D. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole and is flush with adjoining surface.

END OF SECTION 220518

KSU DESIGNERS NOTES:

1. Coordinate finished with KSU and Architect. Specification as is requires all exposed penetrations in occupied areas to be chrome plated and prime paint finish for unoccupied areas.

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
- B. Related Requirements:

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 THERMOMETERS, THERMOWELLS, AND PRESSURE GAUGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - Ashcroft

Marshalltown Instruments, Inc.
Taylor
3M
Trerice (H.O.) Co.
Weiss Instruments, Inc.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum or high density plastic 9-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated. Unit to have 180 deg adjustment in vertical plane, 360 deg adjustment in horizontal plane, with locking device.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in 2 deg F.
6. Window: Glass.
7. Stem: Copper-plated steel, or brass Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR (copper nickel (90-10)) or CUNI (copper nickel (70-30)).
4. Material for Use with Steel Piping: Stainless Steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled (where maximum system temperature is less than 160°F) drawn steel on all vibrating equipment; minimum 4-1/2" diameter above 6'- 0" above floor, 3-1/2" below 6'-0" above floor.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Plastic.
9. Ring: Stainless steel.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install pressure gages in the following locations:
1. Inlet and discharge of each pressure-reducing valve.

2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.
4. Inlet and outlet of each heat exchanger.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Industrial-style, liquid-in-glass type thermometers to be installed at inlet and outlet shall be located at the following:
 1. On the supply water temperature downstream of the main ASSE 1017 mixing valve and also on the return water coming from the hot water recirculating system.
 2. Each hydronic heat exchanger.
 3. Each hydronic heat-recovery unit.
 4. Each thermal-storage tank.
- B. Thermometer stems shall be of length to match thermowell insertion length.
- C. Thermometers installed with improper ranges will be required to be replaced by the contractor at no additional costs after system commissioning is complete.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold Water Piping: 0 to 100 deg F.
- B. Scale Range for Domestic Hot and Recirculation Water Piping: 20 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Sealed, direct mounted, metal case pressure gages to be installed at the following locations:
 1. Inlet and outlet of each hydronic system with medium greater than 160°F and steam pressure-reducing valve.
- B. Liquid-filled, direct-mounted, metal case pressure gauges to be installed at the following locations:
 1. Inlet and outlet of each hydronic system with medium less than 160°F.

- C. Gages installed with improper ranges will be required to be replaced by the contractor at no additional costs after system commissioning is complete.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

Select proper range for relevant utilities below. Select gages so typical operating condition is near the midpoint of the scale.

- A. Scale Range for Domestic-Water Piping:
 - 1. 0 to 100 psi.

PART 4 - SUPPLEMENTAL REQUIREMENTS:

4.1 TEMPERATURE GAUGE INSTALLATION

- A. All gauges to be rated for fluid applications with expected operating pressure to fall in the middle of the pressure range.
- B. Thermometers shall be located in the following locations (minimum):
 - 1. Discharge from domestic water heaters and downstream of master mixing valve supply to building.
 - 2. Supply and return to heat exchangers, both domestic and hydronic.

4.2 PRESSURE GAUGE INSTALLATION

- A. All gauges to be rated for fluid applications with expected operating pressure to fall in the middle of the pressure range
- B. Gauges shall include isolation ball or gate valve (steam), schedule 80 nipples, fittings and pipe. Provide tee fitting between isolation valve and gauge.
- C. Pressure gauges shall be located in the following locations (minimum):
 - 1. Suction and discharge of pumps.
 - 2. At pressure reducing fill valves both upstream and downstream.
 - 3. All PRV (pressure regulating valve) stations both upstream and downstream of station.
 - 4. Upstream and downstream of main building backflow devices, i.e. fire system double check and domestic water RPBP (RPZ).

4.3 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Mercury type thermometers are not permitted.

- C. All gauges to be rated for fluid applications with expected operating pressure to fall in the middle of the pressure range. Select range for various utilities above.

END OF SECTION 220519

KSU DESIGNERS NOTES:

1. Dial thermometers minimum 4½" diameter will be acceptable in certain fluid applications. Consult with OUA.

SECTION 230523.13 – GENERAL DUTY VALVES AND STRAINERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.2 DESCRIPTION OF WORK

- A. Extent of valves required by this section are indicated on drawings and/or specified in other Division 22 sections.
- B. Valves furnished as part of factory fabricated equipment, are specified as part of equipment assembly in other Division 22 sections.

1.3 QUALITY ASSURANCE

- A. Valve Types: Provide valves of same type by same manufacturer.
- B. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.
- C. Codes and Standards:
 - 1. MSS Compliance: Mark valves in accordance with MSS 25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
 - 2. ANSI Compliance: For face to face and end to end dimensions of flanged or welded end valve bodies, comply with ANSI B16.10 "Face to Face and End to End Dimensions of Ferrous Valves".
 - 3. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73 1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78 1 "Pressure Rating Standard for Pipeline Strainers Other than "Y" Type".
 - 4. ASME Compliance:
 - a. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - b. ASME B31.1 for power piping valves.
 - c. ASME B31.9 for building services piping valves.
 - 5. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.4 SUMMARY

A. Section Includes:

1. Ball Valves
2. Butterfly Valves
3. Check (Silent Type)
4. Check (Swing Type)
5. Gate Valves
6. Globe Valves
7. Strainers
8. Flow Measuring Balance Valves
9. Chainwheels.

1.5 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of valve. Include pressure drop curve or chart for each type and size of valve and strainer. Submit schedule showing manufacturer's figure number, size, location and features for each required valve and strainer. Indicate sizes being supplied.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set butterfly valves closed or slightly open.
 4. Set angle, gate, and globe valves closed to prevent rattling.
 5. Set ball and plug valves open to minimize exposure of functional surfaces
 6. Set butterfly valves closed or slightly open.
 7. Block check valves in either closed or open position.
- B. Use the following precautions during storage:

1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B16.1 for flanges on iron valves.
 2. ASME B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 4. ASME B31.1 for power piping valves.
 5. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Actuator Types:
1. Gear Actuator: For valves NPS 8 and larger.
 2. Handlever: For valves NPS 6 and smaller.
 3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.
- G. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.2 BALL VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ball Valves 1" and smaller:
 - a. Conbraco (Apollo).
 - b. Crane.
 - c. Grinnell.
 - d. Jenkins.

- e. Stockham.
- f. Watts.
- g. Milwaukee.
- h. Milwaukee Butterball.
- i. Hammond.

2. Ball Valves – 1-1/4” and larger

- a. Conbraco (Apollo).
- b. Grinnell.
- c. Nibco.
- d. Stockham.
- e. Watts.
- f. Milwaukee.
- g. Milwaukee Butterball.

B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim (2-1/2” and Smaller):

1. Description:

- a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
- b. Standard: MSS SP-110.
- c. Body Design: Two piece.
- d. Body Material: Forged brass or bronze.
- e. Seats: PTFE or RPTFE.
- f. Stem: Brass or bronze, blowout proof pressure retaining.
- g. Ball: Chrome-plated brass.
- h. Port: Full.
- i. Ends: Threaded or Soldered.
- j. Ends: Press with Buna-N or EPDM O-Ring Seal.
- k. Maximum Rating:
 - 1) CWP: 600 psig.
 - 2) Similar to Nibco T/S-585-66-LF.

2.3 BUTTERFLY VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Standard Duty Butterfly Valves:

- a. Crane.
- b. Dezurik.
- c. Grinnell.
- d. Milwaukee.
- e. Nibco.
- f. Victaulic.

B. Iron, Single-Flange Butterfly Valves (2-1/2” and Larger):

1. Description:

- a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
- b. Body Design: Lug type; suitable for bubble tight bidirectional dead-end service at rated pressure without use of downstream flange.
- c. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- d. Seat: Material shall be reinforced with cartridge or metal as required and shall be EPDM (EPT) suitable for 275 deg F. Seat and backing ring shall be replaceable in field.
- e. Stem: One or two-piece ASTM A582 416 stainless steel. Offset from the disc centerline to provide complete 360 degree circumferential seating
- f. Disc: Aluminum bronze disc to UNS C95500, with pressure responsive elastomer seat.
- g. Liner: EPDM rubber.
- h. Ends: Single flange
- i. Maximum Rating:
 - 1) NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - 2) NPS 14 to NPS 24, CWP Rating: 150 psig.
 - 3) Similar to be Nibco LD Series.
- j. Handles: Valves thru 6" shall have 10 position leverlock handle. Valves 8" and above shall have gear operators with hand wheels.

C. Iron, Grooved-End Butterfly Valves, 300 CWP (2-1/2" and Larger):

1. Description:

- a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
- b. Body Design: Lug type; suitable for bubble tight bidirectional dead-end service at rated pressure without use of downstream flange.
- c. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- d. Seat: Material shall be reinforced with cartridge or metal as required and shall be EPDM (EPT) suitable for 275 deg F. Seat and backing ring shall be replaceable in field.
- e. Stem: One- or two-piece 416 stainless steel. Offset from the disc centerline to provide complete 360 degree circumferential seating
- f. Disc: Aluminum bronze disc to UNS C95500, with pressure responsive elastomer seat.
- g. Ends: With copper tubing sized grooved ends.
 - 1) NPS 2-1/2 to NPS 8, CWP Rating: 300 psig.
 - 2) NPS 10 to NPS 24, CWP Rating: 200 psig.
 - 3) Similar to model Victaulic model Vic-300 Master Seal.
- h. Handles: Valves thru 6" shall have 10 position leverlock handle. Valves 8" and above shall have gear operators with hand wheels.

2.4 CHECK VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Crane.
 2. Grinnell.
 3. Hammond.
 4. Jenkins.
 5. Nibco.
 6. Stockham.
- B. Bronze Spring Loaded Check Valves with Bronze Disc (2" and smaller):
1. Description:
 - a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
 - b. Standard: MSS SP-139.
 - c. Body Design: Installation in any position.
 - d. Body Material: ASTM B584 Alloy C87600.
 - e. Disc: Resilient PTFE.
 - f. Spring: Stainless Steel S31600
 - g. Ends: Threaded.
 - h. Rating: Class 125.
 - 1) CWP Rating: 250 psig.
 - i. Similar to Nibco T/S-480-Y-LF.
- C. Iron Swing Check Valves with Metal Seats (2-1/2" and larger):
1. Description:
 - a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
 - b. Standard: MSS SP-71, Type I.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126 Class B, gray iron with bolted bonnet.
 - e. Trim: Bronze.
 - f. Disc: Bronze.
 - g. Gasket: Asbestos free.
 - h. Ends: Flanged.
 - i. Rating: Class 125
 - 1) NPS 2-1/2 to NPS 12, 200 psig CWP, 125 SWP.
 - 2) NPS 14 to NPS 24, 150 psig CWP, 100 SWP.
 - j. Similar to Nibco model F-910-LF.

2.5 CHECK (SILENT TYPE) VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mueller Steam Specialty.
2. Williams-Hager.
3. Metra-flex.

B. Globe, Center-Guided Check Valves with Metal Seat (2" and smaller):

1. Description:
 - a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
 - b. Standard: MSS SP-125.
 - c. Body Material: Bronze, or ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Seat: Bronze or Brass.
 - f. Disc: Brass.
 - g. Ends: Threaded.
 - h. Rating: Class 125.
 - 1) CWP Rating: 200 psig.
 - i. Similar to Mueller Steam Specialty model 303AP.

C. Iron, Globe, Center-Guided Check Valves with Metal Seat (2-1/2" and larger):

1. Description:
 - a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
 - b. Standard: MSS SP-125.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze or stainless steel.
 - g. Rating: Class 125.
 - 1) NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - 2) NPS 14 to NPS 24, CWP Rating: 150 psig.
 - h. Similar to Mueller Steam Specialty model 105 MAP.

2.6 GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Gate valves 2-1/2" and larger:

- a. Crane.
- b. Grinnell.
- c. Hammond.
- d. Jenkins.
- e. Lunkheimer.
- f. Milwaukee.
- g. Nibco.

- h. Powell.
- i. Stockham.

B. Iron Gate Valves, OS&Y:

1. Description:

- a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
- b. Standard: MSS SP-70, Type I and federal specification WW B 58, Type I, Class 1.
- c. Body Material: ASTM A 126, Class B gray iron with bolted bonnet.
- d. Trim: Bronze.
- e. Disc: Solid wedge, bronze or cast iron (NPS 4 and larger).
- f. Packing and Gasket: Asbestos free.
- g. Stem: Rising.
- h. Ends: Flanged.
- i. Rating: Class 125.
 - 1) NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - 2) NPS 14 to NPS 24, CWP Rating: 150 psig.

2.7 GLOBE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Crane.
- 2. Grinnell.
- 3. Hammond.
- 4. Jenkins.
- 5. Nibco.
- 6. Stockham.

B. Bronze Globe Valves, RS (2" and Smaller):

1. Description:

- a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
- b. Standard: MSS SP-80, Type 2 and federal specification WW V 51, Class A, Type I and II.
- c. Body Material: ASTM B584, bronze with integral seat and screw in bonnet.
- d. Stem: ASTM B21 UNS C46400 Bronze, Rising.
- e. Packing: Asbestos free.
- f. Seat: PTFE.
- g. Handwheel: Malleable iron.
- h. Ends: Threaded.
- i. Rating: Class 125.
 - 1) Disc: Bronze, PTFE, or Stainless Steel.
 - 2) CWP Rating: 200 psig.
 - 3) SWP Rating: 150 psig.

C. Iron Globe Valves, OS&Y (2-1/2" and Larger):

1. Description:

- a. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
- b. Standard: MSS SP-85, Type I.
- c. Body Material: ASTM A 126, Class B gray iron with bolted bonnet.
- d. Stem: Bronze, Rising.
- e. Packing and Gasket: Asbestos free.
- f. Operator: Handwheel (Malleable Iron or Cast Iron) or chainwheel.
- g. Ends: Flanged.
- h. Rating: Class 125.
 - 1) Trim: Bronze or Cast Iron.
 - 2) Disc: Bronze, Brass, or Cast Iron (4" and larger).
 - 3) CWP Rating: 200 psig.

2.8 STRAINERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong.
2. Crane.
3. Sarco.
4. MEPCO.
5. Metraflex.
6. Mueller Steam Specialty.

B. Y-Pattern Strainers:

1. UL classified in accordance with ANSI/NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.
2. Body: ASTM A 126, Class B or ASTM A48, Class 30 cast iron, with bolted cover and bottom drain connection.
3. Strainer Screen:
 - a. Stainless-steel, 20-mesh strainer (NPS 2 and under)
 - b. Stainless-steel, 0.062" perforated strainer (NPS 2-1/2 and larger)
4. Tapped blowoff plug. Drilled with minimum NPS 1-1/4 for strainers NPS 2-1/2 and larger.
5. End Connections: Threaded ends for strainers NPS 2 and smaller
6. End Connections: Flanged ends for strainers NPS 2-1/2 and larger.
7. End Connections: Grooved NPS 2 and larger.
8. Rating: Class 125 for 2-1/2" and larger.
9. Rating: Class 250 for 2" and under.

2.9 FLOW MEASURING BALANCE VALVES

- A. Flow Measuring Balance Valves, in piping 2" and smaller shall be automatic flow, self-actuating thermostatic recirculating valve and NSF/ANSI 61 certified. Suggested valve is ThermOmega Tech's CircuitSolver.

2.10 CHAINWHEELS

Edit options below and coordinate with Owner.

Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

1. Sprocket Rim with Chain Guides: [Ductile iron] [Ductile or cast iron] [Cast iron] [Aluminum] [Bronze], of type and size required for valve. [Include zinc or epoxy coating.]
2. Chain: [Hot-dip, galvanized steel] [Brass] [Stainless steel], of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Valves shall be provided in suitable locations at each item of equipment, branch circuit, riser, or section of piping as indicated or required for proper and safe operation of the system and to facilitate maintenance and/or removal of all equipment and apparatus. On horizontal pipe runs, install all valve stems vertically up where possible and in no case shall the stems be turned more than 90 degrees from the vertically up position.
- B. Install valves in compliance with manufacturer's installation instructions.
- C. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

- D. Install valves in position to allow full stem movement.
- E. Potable water systems (2" and smaller) shall utilize valves as indicated with soldered connections where used for zone isolation, or threaded connections when used in conjunction with a union for equipment isolation
- F. Potable water systems (2 1/2" and larger) shall utilize valves with flanged connections.
- G. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- H. Make sure check valves are oriented properly for flow and gravity effect, and that they are distant from pump outlets or other turbulence inducing devices.
- I. Install blowdown valves on all strainers 1-1/2" and larger. Blowdown valves to be ball valves for hydronic piping and gate valves for steam and steam condensate piping. Strainer blowdown valves to be sized to match blowdown connection size, but not less than 3/4". Terminate blowdown with hose thread connection and cap or plug.

Edit options below and coordinate with Owner.

- J. Install chainwheels on operators for manual valves [NPS 2-1/2] and larger and more than [84 inches] <Insert dimension> above floor. Extend chains to [60 inches] <Insert dimension> above finished floor.
- K. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. Install valves in compliance with manufacturer's installation instructions.
- B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end or press style options are indicated in valve schedules.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.
 - 7. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

Retain only items and systems relevant to project.

3.4 VALVE SCHEDULE (SYSTEMS LESS THAN 150 PSIG)

A. Ball Valves

1. Pipe NPS 2-1/2 and Smaller: Brass or bronze ball valves, two piece, with brass or bronze trim, full port.
 - a. Valves may be provided with solder-joint ends or press style instead of threaded ends.

B. Butterfly Valves

1. Pipe NPS 2-1/2 and Larger:
 - a. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze, Ductile-iron, or Stainless-steel disc, 200 CWP, and EPDM seat.
 - b. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze, Ductile-iron, or Stainless-steel disc, 150 CWP, and EPDM seat.
 - c. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 8: 300 CWP.
 - d. Iron, Grooved-End Butterfly Valves, NPS 10 to NPS 24: 200 CWP.

C. Check Valves

1. Pipe NPS 2 and Smaller:
 - a. Bronze Valves: Valves may be provided with solder-joint ends or press style instead of threaded ends.
 - b. Bronze swing check valves with bronze disc, Class 150.
2. Pipe NPS 2-1/2 and Larger:
 - a. NPS 2-1/2 to NPS 12: Iron swing check valves with lever closure control, Class 125.
 - b. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.

D. Check (Silent Type) Valves

1. Pipe NPS 2 and smaller
 - a. Bronze or Iron, globe, center-guided check valves metal seat, class 125.
2. Pipe NPS 2-1/2 and Larger:
 - a. Iron, globe, center-guided check valves metal seat, Class 125.

E. Gate Valves

1. Pipe NPS 2-1/2 and Larger: Iron gate valves, Class 125, with flanged ends.

F. Globe Valves

1. Pipe NPS 2 and Smaller: Bronze angle or globe valves, Class 125, Bronze, PTFE or Stainless Steel disc, with soldered or threaded ends.
2. Pipe NPS 2-1/2 and Larger: Iron globe valves, Class 125, with flanged ends.

G. Strainers

1. Pipe NPS 2 and Smaller: Y-pattern strainers, Class 125 with soldered or threaded ends.
2. Pipe NPS 2-1/2 and Larger: Y-pattern strainers, Class 250, with flanged ends.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
1. Submittal Data: Information on each valve, including parts list and supplier contact name and phone number, shall be submitted to the A/E for review. This information shall be included in the operational maintenance manuals.
 2. Valves shall be by one manufacturer whenever possible.
 3. Drain valves and manual air vents shall be comprised of a full port ball valve with a capped hose end connection. The cap shall be attached to the valve with a chain.
 4. Domestic systems (2" and smaller) shall utilize valves as indicated with soldered connections where used for zone isolation, or threaded connections when used in conjunction with a union for equipment isolation.
 5. Domestic systems shall utilize full port quarter-turn ball valves for isolation up to and including 2-1/2". Butterfly valves to be used for 3" and above.
 6. Valve bonnet must be repairable flanged or union style.
 7. No valves are to be installed above inaccessible ceilings or within chases or shafts.
 8. Grooved piping systems and valves are not allowed to be installed above inaccessible ceilings or within chases or shafts.

END OF SECTION 230523

KSU DESIGNERS NOTES:

1. Grooved piping systems and valves are not allowed to be installed above inaccessible ceilings or within chases or shafts.

2. Grooved piping and valves are not to be installed on tower water systems without prior approval by the KSU Project Manager due to past issues on campus related to water treatment issues.
3. Miscellaneous Mechanical Room Replacements: Access to mechanical rooms shall be analyzed for future replacement of large equipment. Manual valves larger than 2" inches diameter and above 7'-0" in height to have chain wheel operators in mechanical equipment type spaces. **REVIEW THIS ON A PROJECT BY PROJECT BASIS.** The plans shall clearly indicate potential restrictions/service areas and detail the areas appropriately. Coordinate all systems to provide maximum head room with no items below 7'-0" A.F.F. Chain wheels' installation shall be coordinated and approved for use by OUA.
4. The use of gate valves within any hydronic, plumbing system shall be reviewed with OUA prior to including in specifications. If gate valves are used for steam applications, they shall be specified to have rising stem. This applies to all steam and steam condensate systems. Avoid Non-rising stem valves and only allowed with written approval by OUA mechanical engineers.
5. Drain valves and manual air vents shall be comprised of a full port ball valve with a capped hose end connection. The cap shall be attached to the valve with a chain.
6. Auto air vents (only in unfinished or mechanical spaces) shall be Hoffman 79 or approved equivalent. All shall be piped to nearest floor drain where possible. All air vents above finished spaces shall be a 3/4" ball drain valve with hose thread connection, cap and chain.
7. Mechanical and pressure joint systems are acceptable on applicable piping services except for steam and condensate.
8. All drain valves shall be ball valves with 3/4" hose adaptor connection. Valve shall be provided with chain on end with solid gasketed end cap
9. Valves shall be provided in suitable locations at each item of equipment, branch circuit, riser or section of piping as indicated or required for proper and safe operation of the system and to facilitate maintenance and/or removal of all equipment and apparatus. Design shall also incorporate interstitial isolation valves for partial system isolation. Number of isolation valves shall be reviewed with OUA engineers.
10. Potable water ball valves shall be quarter-turn, full port, and of bronze construction. All plumbing fixture stop valves shall be 1/4 turn ball type. (Chicago Faucet, McGuire (commercial division), T&S and Watts) Other manufacturers shall be pre-approved by OUA.
11. Potable water systems (2" and smaller): Valves shall have soldered connections where used for zone isolation or have threaded connections when used in conjunction with a union for equipment isolation. Valves 3" and larger with hand wheel above 7'-6" A.F.F. shall have chain wheel actuator, with chain down to 7'-0" A.F.F. if located in mechanical rooms.
12. Potable water systems (2-1/2" and larger): All valves shall have flanged connections.
13. Mechanical and pressure joint systems are acceptable on applicable piping services except for steam and condensate.
14. All buried potable water isolation valves shall be furnished with valve stem key, curb box assembly and lid shall call out water, painted blue and tagged on underside of lid per OUA requirements.

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.
8. Roof equipment supports.

B. Related Requirements:

Retain only relevant sections below.

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. [Section 220548 "Vibration and Seismic Controls for Plumbing"] [Section 220548.13 "Vibration Controls for Plumbing"] for vibration isolation devices.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support. For equipment curbs supply manufacturer's certified load bearing data.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support, indicating dimensions, weights, required clearances, and methods of assembly of components.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.
- C. Codes and Standards:
 - 1. Code Compliance: Unless requirements are exceeded herein, comply with applicable codes pertaining to product materials and installation of supports and anchors. For Ohio projects, follow the State Architect's "Handbook of Instruction" and Ohio Basic Building Code for maximum hanger spacing requirements.
 - 2. Comply with NFPA 13 for hangers and supports used as components of fire protection systems. Include listing and labeling by UL and FM.

PART 2 - PRODUCTS

2.1 MANUFACTURERS OF HANGERS AND SUPPORTS:

- A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - 1. B-Line Systems, Inc.
 - 2. Globe Hanger
 - 3. ITT Grinnell Corp.
 - 4. Michigan Hanger
 - 5. Modern Hanger
 - 6. nVent Caddy
 - 7. PHD Manufacturing, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for Plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

Retain below if seismic restraints are required.

- 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.3 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper, factory-fabricated components or nylon. Plated copper is not acceptable.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel or stainless steel.

2.4 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
- B. Cushion Clamps: UL Classified 2043 (25/50), Molded with high strength Thermoplastic Elastomer (TPE). Temperature rating: -65°F to 275°F. Clamps to be by Hydra-Zorb.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psi or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with 100-psi ASTM C 552, Type II cellular glass with 100-psi minimum compressive strength.
- C. Insulation-Pipe Supports for Cold or Hot Piping: Where insulated piping is supported from unistrut or other similar systems, crush resistant insulation clamps similar to ZSI Cush-A-Therm, K-Flex® 360 Insulated Pipe Support, and Klo-Shure insulation couplings will be acceptable.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Indoor Applications: Zinc-coated or stainless-steel.
 - 2. Outdoor Applications: Stainless steel.

2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
 - 1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Hardware: Galvanized steel or polycarbonate.
 - 4. Accessories: Protection pads.
- C. Low-Profile, Single Base, Single-Pipe Stand:

Engineer to provide detail of assembly including pipe support types and heights.

- 1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Vertical Members: Two, galvanized (indoor applications) or stainless-steel (outdoor applications), continuous-thread 1/2-inch rods.
 - 4. Horizontal Member: Adjustable horizontal, galvanized (indoor applications) or stainless-steel (outdoor applications) pipe support channels.
 - 5. Pipe Supports: Roller, Strut clamps, Clevis hanger, or Swivel hanger as detailed on drawings.
 - 6. Hardware: Galvanized (indoor applications) or Stainless steel (outdoor applications).
 - 7. Accessories: Protection pads.
 - 8. Height: See details on drawings.
- D. High-Profile, Single Base, Single-Pipe Stand:

Engineer to provide detail of assembly including pipe support types and heights.

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.
3. Vertical Members: Two, galvanized (indoor applications) or stainless-steel (outdoor applications), continuous-thread 1/2-inch rods.
4. Horizontal Member: One, adjustable height, galvanized (indoor applications) or stainless-steel (outdoor applications) pipe support slotted channel or plate.
5. Pipe Supports: Roller or Clevis hanger as detailed on drawings.
6. Hardware: Galvanized (indoor applications) or stainless steel (outdoor applications).
7. Accessories: Protection pads, 1/2-inch continuous-thread galvanized-steel rod (indoor applications) , 1/2-inch continuous-thread stainless-steel rod (outdoor applications).
8. Height: See details on drawings.

E. High-Profile, Multiple-Pipe Stand:

Engineer to provide detail of assembly including pipe support types and heights.

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; vulcanized rubber or molded polypropylene.
3. Vertical Members: Two or more, galvanized (indoor applications) or stainless-steel (outdoor applications) channels.
4. Horizontal Members: One or more, adjustable height, galvanized (indoor applications) stainless-steel (outdoor applications) pipe support.
5. Pipe Supports: Roller, Strut clamps, Clevis hanger, Swivel hanger as detailed on drawings.
6. Hardware: Galvanized (indoor applications) or Stainless steel (outdoor applications).
7. Accessories: Protection pads, 1/2-inch continuous-thread rod.
8. Height: See details on drawings.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 ROOF EQUIPMENT SUPPORTS

SPECIFIER NOTE: COORDINATE TYPE OF ROOF EQUIPMENT SUPPORTS USED WITH ROOF CONSTRUCTION. VERIFY WHO FURNISHES AND WHO INSTALLS ROOF EQUIPMENT SUPPORTS WITH ARCHITECT.

- A. Refer to the drawings, schedules and applicable specification sections for roof equipment supports indicated to be furnished by the unit manufacturer.

SPECIFIER NOTE: DELETE ABOVE, BELOW OR BOTH (IF ROOF EQUIPMENT SUPPORTS ARE SPECIFIED IN DIVISION 7) TO SUIT PROJECT REQUIREMENTS.

B. Fabricated Roof Equipment Supports:

1. General: Construct roof equipment supports using minimum 18-ga galvanized steel with fully mitered and welded corners, 3" cant, internal bulkhead reinforcing, integral base plates, pressure treated wood nailer, and 18-ga galvanized steel counterflashing.
2. Configuration: Construct of sizes as indicated, compensate for slope in roof so top of support is dead level.
3. Pipe Boots: Provide boots for piping, power conduit and control conduit as required by pipe curb manufacturer. Boot to be expandable, designed to accommodate the pipe or conduit size utilized, and capable of maintaining a weather-tight seal even with minor vibration in piping.
4. Manufacturer: Subject to compliance with requirements, provide roof equipment supports of one of the following:
 - a. Custom Curb
 - b. Pate Co.
 - c. Roof Products and Systems (RPS)
 - d. Thycurb Division; Thybar Corp.

2.10 MATERIALS

- A. Aluminum: ASTM B 221.
- B. Carbon Steel: ASTM A 1011/A 1011M.
- C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; galvanized.
- D. Stainless Steel: ASTM A 240/A 240M.
- E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- F. Metal Framing: NEMA STD ML 1.
- G. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards. Material coatings for interior use shall be electro-plated zinc (ASTM B633), or mill galvanized (ASTM A525 G90). For exterior use, materials shall be hot-dip galvanized after fabrication (ASTM A386).
- H. Bolts and Nuts: ASME B18.10 or ASTM A183, steel, hex-head, track bolts and nuts. Use galvanized or stainless steel for use in moist environments.
- I. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Non-staining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

3.2 INSPECTION:

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.3 PREPARATION:

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washer and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire protection piping independently of other piping.
- D. Prevent electrolysis in support of copper tubing by use of copper or nylon clamps and supports which are copper or stainless steel, or by other recognized industry methods. Copper-plated clamps in direct contact with copper piping is not acceptable.
- E. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- F. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- G. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- H. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- I. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- J. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
- Retain below if section 077200 is included in specifications.**
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- Q. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

3.5 EQUIPMENT SUPPORTS

- A. Provide painted structural steel stands to support equipment from structure overhead or to support equipment above floor.
- B. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.
- C. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- D. Provide lateral bracing, to prevent swaying, for equipment supports.

3.6 ROOF EQUIPMENT SUPPORTS:

Select one of the two paragraphs below. First paragraph is for projects where equipment supports are installed by division 07 work. Second paragraph is when provided and installed by this contractor.

- A. Furnish roof equipment supports to Contractor for installation as part of work of Division 7; not work of this section.
- B. Install roof equipment supports in compliance with manufacturer's instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive accessory units, vapor barriers, roof insulation, roofing and flashing as required to ensure that each element of the work performs properly and that combined elements are waterproof and weathertight. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures. Meet all requirements necessary to maintain the roofing manufacturer's warranty as applicable.

3.7 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.8 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.9 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 220501 Basic Materials and Methods for Plumbing for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.10 HANGER AND SUPPORT SCHEDULE

- A. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- C. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- D. Use stainless-steel pipe hangers and stainless-steel attachments for outdoor and hostile environment applications.
- E. Use copper or nylon pipe clamps and copper or stainless-steel attachments for copper piping and tubing.
- F. Use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with

MSS SP-69 and manufacturer's published product information. Use only one type of one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Copper-plated clamps are not acceptable for copper-piping systems. Clamps in direct contact of copper piping to be copper or nylon. Provide felt lined hangers or clamps for uninsulated refrigerant piping to eliminate transmission of sound and vibration. Perforated strap hangers shall not be used in any work. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 4. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 5. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 8. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
- I. Vertical-Piping Clamps: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with MSS SSP-58, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Copper-plated clamps are not acceptable for copper-piping systems. Clamps in direct contact of copper piping to be copper or nylon. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, expansion shells, inserts or beam clamps selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information.
1. All beam clamps shall be installed with a retaining strap to grasp two opposing sides of structure to prevent possible movement of the clamp due to vibration.
 2. Select size of building attachments to suit hanger rods.
 3. Provide copper-plated building attachments for copper-piping systems.
 4. "C" clamps shall not be permitted except on fire protection piping.
 5. Install building attachments at required locations within concrete or on structural steel for proper piping support.
 6. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - b. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 - c. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - d. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - e. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - f. C-Clamps (MSS Type 23): For structural shapes.
 - g. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - h. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - i. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 - j. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 - k. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 - l. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - 1) Light (MSS Type 31): 750 lb.
 - 2) Medium (MSS Type 32): 1500 lb.
 - 3) Heavy (MSS Type 33): 3000 lb.
 - m. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - n. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 - o. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- p. Space attachments within maximum piping span length indicated below. Install additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. For new concrete, install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

- 1) Two or one-end threaded rod sizing for various support loads shall be as follows:

ROD DIAMETER	MAXIMUM LOAD (LBS.)
3/8"	610
1/2"	1130
5/8"	1810
3/4"	2710
7/8"	3770
1"	4960
1-1/8"	6230
1-1/4"	8000
1-1/2"	11630
1-3/4"	15700
2"	20700
2-1/4"	27200
2-1/2"	33500

Note limitations on structure supporting rods.

- 2) For reference purposes, the following table provides filled weights of steel piping for various sizes:

PIPE SIZE	FILLED PIPE WEIGHT (LB/FT)
1/2"	1.0
3/4"	1.4
1"	2.1
1-1/4"	3.0
1-1/2"	3.6
2"	5.1
2-1/2"	7.9
3"	10.8
4"	16.3
6"	31.5
8"	50.2
10"	74.6
12"	98.6
14"	114.4
16"	141.8
18"	171.9
20"	204.4
22"	240.4
24"	278.7
26"	319.8

28"	363.6
30"	410.1
32"	459.3
34"	511.3
36"	565.9

- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- P. Piping support spacing:
1. All piping shall be supported at distances not exceeding the spacing in the following table. This table is intended for general distribution piping. Within equipment rooms, hangers must be arranged to provide full support of piping. No piping is to be supported by, or impose a load upon the equipment to which it is connected.
 2. Install hangers for steel piping with the following maximum spacing and minimum rod sizes unless hanger spacing is:
 - a. Specifically indicated on drawings
 - b. Indicated in other Division 22 specification sections for special applications
 - c. Required to be more frequently by State or local codes
 3. Maximum steel piping hanger supports
 - a. NPS 3/4: Maximum span, 7 feet.
 - b. NPS 1: Maximum span, 7 feet.
 - c. NPS 1-1/2: Maximum span, 9 feet.
 - d. NPS 2: Maximum span, 10 feet.
 - e. NPS 2-1/2: Maximum span, 11 feet.
 - f. NPS 3 and Larger: Maximum span, 12 feet.
 4. Maximum drawn-temper copper piping hanger supports:
 - a. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - b. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - c. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.

- d. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - e. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - f. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - g. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- R. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- S. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- T. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
- U. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- V. Horizontal Piping: Comply with the following installation requirements.
- 1. Individual hangers for uninsulated piping not specified to be supported with roller hangers may be supported with either adjustable band hangers or adjustable steel clevis hangers.
 - 2. Individual hangers for insulated piping not specified to be supported with roller hangers shall be adjustable steel clevis hangers.
 - 3. Support the following horizontal piping using adjustable roller hanger supports MSS Type 43 for twelve (12) inches and below and MSS Type 41 for fourteen (14) inches and above:

Enter size of piping to be installed on roller hangers.

- a. Piping over 2 4 6 (choose one size) inches in size transporting medium above 150 deg. F.
 - b. All piping 4 6 8 10 (choose one size) inches in size and above, regardless of medium.
4. All piping on horizontal trapeze supports.
- W. Heavy duty trapezes may be utilized for multiple horizontal pipes where applicable. Design of same shall be by trapeze manufacturer considering weight, available structure, pipe medium, material, etc. Supports for individual piping group on trapezes shall be as specified for individual piping.
- X. Shields: Where insulation is indicated on piping, install galvanized protective shields for sizes 6" and smaller. Install thermal hanger shield inserts with same thickness as pipe insulation.
- Y. Insulated Piping: Comply with the following installation requirements.
- 1. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
 - 2. Clamps:
 - a. Attach clamps and spacers to piping.

- 1) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - 2) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 3) Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
3. Saddles for piping above ambient conditions: Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated where piping is eight (8) inches in diameter or larger, or piping of any size on roller hanger supports, install protection saddles. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers. Constructed of 360 deg insert of high density, 100 psi, water-proofed calcium silicate, encased in 360 deg sheet metal shield. Provide assembly of same thickness as adjoining insulation, with sufficient width to prevent hanger bearing on insulation.
4. Saddles for piping below ambient conditions: Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Pipes NPS 4 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield. Hardwood block saddles to be provided in sufficient width to prevent hanger bearing on insulation. Multiple hardwood block sections shall be installed on piping at angles and quantities recommended by support manufacturer.
5. Shield Dimensions for Pipe: Install MSS Type 40, protective shields. Shields shall span an arc of 180 degrees. Not less than the following lengths and thickness:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Hangers in contact with copper pipe shall be copper or nylon. Plated copper not acceptable.

- C. On domestic hot or recirculation hot water copper pipe systems, Hydra-Zorb (-65 to 275 deg F) supports to be used on any unistrut type support structures. All other insulated piping systems are to have continuous insulation with a continuous vapor barrier.
- D. All outdoor miscellaneous metal equipment supports not indicated to be stainless steel construction shall be galvanized steel. Spray-on galvanizing shall be applied to all disturbed areas. All indoor miscellaneous metal equipment supports shall be black iron, primed and painted or galvanized.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.
4. Underground-type plastic line markers.
5. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 8. Fasteners: Stainless-steel rivets or self-tapping screws.
 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: Size letters according to ASME A13.1 for piping. Abbreviate only as necessary for each application length.

2.3 VALVE TAGS

- A. Description: 1-1/2" diameter stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. Numbers to be sequenced. The tag engraving shall be filled with black enamel.
1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Tag Material: Plastic, 3/32-inch minimum thickness engraved plastic laminate valve tags and having predrilled or stamped holes for attachment hardware.
 3. Fasteners: Brass wire-link chain, brass or stainless steel beaded chain, or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system service, system abbreviation (as shown on valve tag), location of valve

(room or space), normal-operating position (open, closed, or modulating), equipment or area isolated, and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.
2. For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with plastic (plexiglass) panel. Submit valve schedule for Engineer's review prior to mounting.

C. UNDERGROUND-TYPE PLASTIC LINE MARKERS:

1. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
2. Provide multi-ply tape consisting of solid aluminum foil core between 2 layers of plastic tape.

2.4 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature:
 - a. Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE".
 - b. For confined space identification: "Danger" with the words "Permit-Required Confined Space. Do Not Enter".
 4. Furnish a quantity of 24 lockout tags, professionally pre-printed with the word "Danger" in white lettering on red background with the words "Do Not Start. Equipment Locked Out" following.
 5. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Equipment labels shall be located where accessible and easily seen from the front of the equipment. When the equipment itself is not able to accept the label (i.e. pressure sensitive tape does not stick to the surface) the tag shall be mounted in an appropriate location on the wall. Equipment tags shall include such information as make, model, capacity, voltage, static pressure ratings, CFM, GPM, TDH, HP, Building Automation System (BAS) tag number and pressure settings based on actual system setup at time of commissioning.
- C. At Installer's option, where equipment to be identified is concealed above acoustical ceiling or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).
- D. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.
- E. Provide labels for the following general categories of equipment and operational devices:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Meters, gages, thermometers and similar units.
 - 3. Fuel-burning units including boilers, furnaces, heaters, stills and absorption units.
 - 4. Pumps, compressors, chillers, condensers and similar motor-driven units.
 - 5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units and similar equipment.
 - 6. Tanks and pressure vessels.
 - 7. Strainers, filters, humidifiers, water treatment systems and similar equipment.
- F. All expansion tanks, relief valves and pressure reducing valves shall have system set pressure attached to device once final set point is complete.
- G. Equipment located concealed above ceilings or access doors shall be labeled utilizing an engraved tag or printed label, black 18-point size letters, on white background, mounted on the ceiling grid or on the access door.

3.4 CONFINED SPACE IDENTIFICATION:

- A. Furnish and install confined space identification signs in a conspicuous location where approved by Owner's authorized representative for each permit required confined space. A permit required confined space is defined as a confined space in which an employee's whole body can enter, has an entrance into or exit from the space which is restricted in any way, and is not designed for continuous employee occupancy. In addition, a permit required confined space must have the potential to contain a hazardous atmosphere, contain a material such as fluid or

particles that could trap or asphyxiate an entrant, or contain any other serious safety or health hazard, such as an electrical or mechanical hazard. Examples of permit required confined spaces requiring signs are air handling units, boilers, cooling tower sumps, underground tanks, vaults or manholes, etc.

3.5 LABEL INSTALLATION

- A. Pipe labels to be taped around pipe at both ends of label. Do not use plastic bands to hold on pipe markers.
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Locate labels near points where pipes enter into and exit from concealed spaces (fixed ceiling, shaft, underground, or similar concealment) and at maximum intervals of 50 feet in each space where pipes are exposed or concealed by removable ceiling system. Reduce intervals to 25 feet in areas of congested piping and equipment. Label piping at both sides of wall or floor penetrations.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
 - 8. Main isolation valves located concealed above ceilings or access doors shall be labeled utilizing an engraved tag or printed label, black 18-point size letters, on white background, mounted on the ceiling grid or on the access door.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
 - 1. Plumbing Vent: White letters on a safety-green background.
 - 2. Sanitary Drain or Sewer Piping: White letters on a safety-green background.
 - 3. Storm Drain or Sewer Piping: White letters on a safety-green background.
 - 4. Domestic Cold Water: White letters on a safety-green background.
 - 5. Domestic Hot Water: Black letters on a safety-yellow background.
 - 6. Compressed Air Piping: Black letters on a safety-yellow background.
 - 7. Deionized Water Piping: Black letters on a safety-yellow background.
 - 8. Distilled Water Piping: Black letters on a safety-yellow background.
 - 9. Medical Air Piping: White letters on a safety-blue background.
 - 10. Nitrogen Piping: White letters on a safety-green background.
 - 11. Nitrous Oxide Piping: Black letters on a safety-yellow background.
 - 12. Oxygen Piping: Black letters on a safety-yellow background.
 - 13. Vacuum Piping: Black letters on a safety-yellow background.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Colors:
 - a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
 - b. Flammable Fluids: Black letters on a safety-yellow background.
 - c. Combustible Fluids: White letters on a safety-brown background.
 - d. Potable and Other Water: White letters on a safety-green background.
 - e. Compressed Air: White letters on a safety-blue background.

C. UNDERGROUND PIPING IDENTIFICATION:

- 1. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Identification shall comply with ANSI A13.1 for lettering size, length of color field, colors and viewing angles of identification.
- C. Valve tags shall include an abbreviation for the type of service.
 - 1. Plumbing Systems: DCW=potable cold water; DHW=potable hot water; DRHW=re-circulated hot water; GAS=natural gas.
- D. Coordinate exposed labels on ceiling grids, access doors, etc. with KSU OUA prior to installation.

- E. Valve Chart: A typewritten directory of all valves shall be framed under glass and wall mounted. Coordinate location with KSU OUA. The valve list shall include the valve number, type of service, size, approximate location, and equipment or area isolated. A copy of the valve chart shall be included in the O&M manual.
- F. Flow arrows shall be reviewed by Associate prior to installation to verify proper direction and application.
- G. Pipe labels and equipment tags to be coordinated with OUA and A/E team. Colors to be as developed and specified by OUA.
- H. Painted stencils will be acceptable for duct labels in lieu of types specified above.

END OF SECTION 220553

KSU DESIGNERS NOTES:

1. Color and system coordinated with OUA and A/E team.

SECTION 220716 - PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following plumbing equipment:

Retain relevant portions below to project

- 1. Domestic water boiler breechings.
- 2. Domestic water heat exchangers.
- 3. Domestic water converters.
- 4. Domestic water, **[hot-water] [cold-water] [and] [chilled-water]** pumps.
- 5. Domestic water storage tanks.
- 6. Domestic water filter housings.

- B. Related Sections:

- 1. Section 220719 "Plumbing Piping Insulation."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Firm with at least 3 years successful installation experience on projects with mechanical insulations similar to that required for this project. Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Domestic Water Boiler Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I. Maximum thermal conductivity (k-value) $k=0.33$ at 75 F mean, up to 900 F.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials. Maximum thermal conductivity (k-value) $k=0.28$ at 75 F mean, up to 200 F for sheet materials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Maximum thermal conductivity (k-value) $k=0.31$ at 75 F mean, up to 250 F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
- I. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type V, without factory-applied jacket. Maximum thermal conductivity (k-value) $k=0.68$ at 500 F mean, up to 1000 Deg F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Industrial Insulation Group, LLC (IIG-LLC).
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Rockwool International.
 - e. Owens Corning.
- J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA maximum thermal conductivity (k-value) $k=0.26$ at 75 F mean, up to 250 F or Type IB maximum thermal conductivity (k-value) $k=0.47$ at 300 F mean,

up to 850 F. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
- K. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type III, without factory-applied jacket. Maximum thermal conductivity (k-value) $k=0.68$ at 500 F mean, up to 1000 F.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Industrial Insulation Group, LLC (IIG-LLC).
 - b. Knauf Insulation.
 - c. Rock Wool.
 - d. Rockwool International.
 - e. Thermafiber, Inc.; an Owens Corning company.
 - f. Owens Corning.
- L. Mineral-Fiber, Preformed Pipe Insulation:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Maximum thermal conductivity (k-value) $k=0.25$ at 100 F mean. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 3. Type II, 1200 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type II, Grade A, with factory-applied ASJ or ASJ-SSL. Maximum thermal conductivity (k-value) $k=0.25$ at 100 F mean. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- M. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. GLT Products.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Knauf Insulation.
 - e. Manson Insulation Inc.
 - f. Owens Corning.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.
 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 1. Water-Vapor Permeance: ASTM 96, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.

3. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.

2.6 SEALANTS

- A. Joint Sealants for Cellular-Glass Products:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Permanently flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 4. Color: White or gray.
- B. FSK and Metal Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
- C. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.
 - 3. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - 2. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.
 - a. Factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.015-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

- D. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel, or 0.062-inch soft-annealed, galvanized steel.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A167 or ASTM A240/A240M, matching insulating jacket material type.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

- A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 1. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - 2. Protect exposed corners with secured corner angles.
 - 3. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 4. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 - 5. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire

ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

6. Stagger joints between insulation layers at least 3 inches.
7. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
8. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
9. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Insulate pumps with fabricated removable/reusable flexible elastomeric pump cover. Cover to be conforming to equipment contours, tight fitting complete with velcro closures.

3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Domestic Water Boiler Breechings:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

Edit and retain two paragraphs below ONLY if insulation or field applied jackets are to be painted. Coordinate with Architect for referenced Division 09 Specifications.

- A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating for outdoor installations.
- D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DOMESTIC WATER BOILER BREECHING INSULATION SCHEDULE

- A. Round, exposed breeching and connector insulation shall be one of the following:
1. Calcium Silicate: 4 inches thick.
 2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
 3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
- B. Round, concealed breeching and connector insulation shall be one of the following:
1. Calcium Silicate: 4 inches thick.
 2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
 3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
- C. Rectangular, exposed breeching and connector insulation shall be one of the following:
1. Calcium Silicate: 4 inches thick.
 2. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
- D. Rectangular, concealed breeching and connector insulation shall be one of the following:
1. Calcium Silicate: 4 inches thick.
 2. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

3.11 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.

Retain only items relevant to the project.

- C. Heat-exchanger (water-to-water for domestic water heating service) insulation shall be one of the following:
1. Calcium Silicate: 3 inches thick.
 2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 2 inches thick.
 4. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches thick.
- D. Steam-to-hot-water converter insulation shall be one of the following:
1. Calcium Silicate: 3 inches thick.
 2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 2 inches thick.
 4. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches thick.
- E. Domestic water pump insulation shall be the following:

1. Flexible Elastomeric: 1 inch thick.
- F. Domestic chilled-water (potable) pump insulation shall be the following:
1. Flexible Elastomeric: 1 inch thick.
- G. Domestic hot-water pump insulation shall be the following:
1. Flexible Elastomeric: 1 inch thick.
- H. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
 2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
- I. Domestic hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:
1. Mineral-Fiber Board: 3-lb/cu. ft. nominal density.
 2. Mineral-fiber pipe and tank.
- J. Domestic water storage tank insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
 2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
- K. Domestic chilled-water (potable) storage tank insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
 2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
- L. Domestic water filter-housing insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
 2. Mineral-Fiber Board: 1 inches thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 1 inches thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

Edit field applied jacket requirements for indoor equipment. Typically these will be left as none.

- C. Equipment, Concealed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. None.
2. [Painted] Aluminum, [Smooth] [Stucco Embossed] with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.032 inch] [0.040 inch] thick.
3. Stainless Steel, [Type 304] [or] [Type 316], [Smooth] [Stucco Embossed], with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.020 inch] [0.024 inch] thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

Edit field applied jacket requirements for equipment. Typically these will be left as none.

C. Equipment, Concealed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.
4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. [Painted] Aluminum, [Smooth] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: 0.016 inch thick.

2. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: 0.010 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. [Painted]Aluminum, [Smooth] [Stucco Embossed] with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.032 inch] [0.040 inch] thick.

2. Stainless Steel, [Type 304] [or] [Type 316], [Smooth] [Stucco Embossed], with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.020 inch] [0.024 inch] thick.

3. <Insert jacket type>.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

END OF SECTION 220716

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:

Retain relevant portions below to project

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Sanitary waste piping exposed to freezing conditions.
5. Floor drains, traps, and sanitary waste piping receiving condensate and cold discharge.
6. Hot service drains and vents.
7. Storm-water piping exposed to freezing conditions.
8. Roof drains and rainwater leaders.
9. Supplies and drains for handicap-accessible lavatories and sinks.

- B. Related Sections:

Retain Sections in subparagraphs below that contain requirements Contractor might expect to find in this Section but are specified in other Sections.

1. Section 220501 "Basic Mechanical Materials and Methods for Plumbing" for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Section 220500 "Basic Mechanical Materials and Methods for Plumbing" for sound stopping materials and requirements.
3. Section 220716 "Plumbing Equipment Insulation."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Firm with at least 3 years successful installation experience on projects with mechanical insulations similar to that required for this project. Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site. Insulation made wet or damaged even after installation shall be removed and replaced.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Maximum thermal conductivity (k-value) $k=0.28$ at 75 F mean, up to 200 F. Comply with ASTM C534, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Maximum thermal conductivity $k=0.25$ at 100 F mean. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type II, Grade A, with factory-applied ASJ or ASJ-SSL. Maximum thermal conductivity $k=0.25$ at 100 F mean. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. GLT Products.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Knauf Insulation.
 - e. Manson Insulation Inc.
 - f. Owens Corning.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below-ambient services.
 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 4. Color: White.

- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 3. Service Temperature Range: 0 to plus 180 deg F.
 - 4. Color: White.

2.6 SEALANTS

- A. Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
- B. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 1-piece 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
 - 2. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.
 - a. Factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.

- 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

- A. Bands:
1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.
 2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy 0.062-inch soft-annealed, stainless steel or 0.062-inch soft-annealed, galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules. Unless otherwise indicated, furnish and install insulations of the same type for the same service throughout this work.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs. Do not staple longitudinal laps on insulation having a vapor retarder. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied integral jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, do not apply staples. Secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges, unions, valves, and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.

3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Section 078413 "Penetration Firestopping" and Section 220501 "Basic Mechanical Materials and Methods for Plumbing" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping" and Section 220501 "Basic Mechanical Materials and Methods for Plumbing".

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Follow manufacturer's written instructions for applying insulation.
- B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- E. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available according to the manufacturer's written instructions.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- F. Coat exposed outdoor flexible elastomeric insulation after adhesive has fully cured with two coats of manufacturer's recommended protective white coating.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
5. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet (4.5 to 6 m) to form a vapor retarder between pipe insulation segments.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
5. See flexible elastomeric insulation application for additional valve and specialty information.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
3. Cover fittings with standard PVC fitting covers. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retardant mastic.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.
5. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.
7. See flexible elastomeric insulation application for additional valve and specialty information.

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive for a completely sealed waterproof installation. Completely sealed system shall comply with requirements of USDA and FDA.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

Edit and retain below ONLY if insulation or jackets are to be painted

- A. Insulation with Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating for outdoor installations.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces, unless otherwise indicated.
 - 2. Underground piping.
 - 3. Flexible connectors on other than cold piping systems.
 - 4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- C. Plumbing Insulation Omitted: Unless otherwise indicated, omit insulation on chrome-plated exposed piping, shock absorbers, unions, strainers, check valves, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, and pre-insulated equipment. See plumbing specifications for possible additional insulation requirements. Trap primer insulation may be omitted on trap primer piping in walls or underground.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements. Where more than one material is indicated for a particular service, choice of listed material is installer's option, unless otherwise specifically indicated.

Reatin only portions below relevant to project.

C. Domestic Cold Water:

- 1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 1/2 inch thick.
- 2. NPS 1-1/4 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 1 inch thick.

D. Domestic Hot and Recirculated Hot Water:

- 1. NPS 1 and Smaller: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with all-service jacket: 1 inch thick.
- 2. NPS 1-1/2 to NPS 2: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with all-service jacket: 1-1/2 inch thick.
- 3. NPS 2-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with all-service jacket: 1-1/2 inch thick.
- E. Stormwater and Overflow through first vertical drop:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retardant all service jacket: 1 inch thick.
- F. Roof Drain and Overflow Drain Bodies / Sumps:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, vapor retardant all service jacket: 1 inch thick.
 - b. Flexible-Elastomeric: 3/4" thick.
- G. Sanitary Waste Piping Where Heat Tracing Is Installed:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with all service jacket: 1-1/2 inches thick.
- H. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (Ice Machines, Kitchen Equipment Drainage, etc.):
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, vapor retardant all service jacket: 1 inch thick.
- I. Hot Service Drains:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all service jacket: 1 inch thick.
- J. Hot Service Vents – Use all service jacket:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all service jacket: 1 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Piping installed within crawl-spaces underneath occupied areas also applies to this section.
- B. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- C. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements. Where more than one material is indicated for a particular service, choice of listed material is installer's option, unless otherwise specifically indicated.

Retain portions below only relevant to project.

D. Domestic Cold Water Piping:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retardant all service jacket: 1-1/2 inches thick.

E. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with all service jacket: 2 inches thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with all service jacket: 1-1/2 inches thick.

G. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with all service jacket: 2 inch thick.

H. Hot Service Vents – Use all service jacket:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type II, with all service jacket: 2 inch thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed- See plans where the following jackets are required:

Edit special jacket requirements for piping here and on drawings including which services. Typically not required in most cases.

- 1. PVC: 20 mils thick.
- 2. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
- 3. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
- 4. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed- See plans where the following jackets are required:

Edit jacket requirements for piping here and on drawings including which services.

- 1. PVC: 20 mils thick.
- 2. [Painted] Aluminum, [Smooth] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: 0.016 inch thick.
- 3. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: 0.010 inch thick.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

B. Insulation Requirements

1. Maintain vapor barrier on all cold water lines.
2. Roof drains sumps inside the buildings shall be insulated tight to deck. Insulate horizontal storm piping inside building until first vertical drop. Vapor barrier is to be maintained.
3. Domestic cold water lines, ice machines drain lines, kitchen equipment drainage, roof drains, basin, first 10'-0" of riser and any horizontal rain leaders shall be insulated to maintain thermal barrier at all times, cutting of insulation to be limited and all raw edges of insulation to be sealed to maintain thermal barrier.
4. Domestic water service main, backflow preventer, meters, and valving associated with service entrance line up shall be insulated. Removable insulation covers will be acceptable.

C. Jacketing Requirements

1. Pipe insulation exposed within reach of the public (within 8' vertical height from floor) or in food service areas shall be covered with 0.5mm thick PVC covers. Johns Manville Zeston, Ceel-Co or equivalent.
2. Any location exposed to weather, fluids (blow-downs), maintenance abuse (within 8' vertical height from floor) shall be protected by a suitable jacket system. This includes piping within mechanical rooms.

END OF SECTION 220719

KSU DESIGNERS NOTES:

1. The following plumbing piping systems shall be insulated (minimum thickness shall be reviewed with OUA engineers based on application and design needs):
 - a. Potable hot, cold and re-circulated water.
 - b. Other piping systems prone to condensation, hot systems for personal protection as directed by OUA.
 - c. Ice machines or kitchen equipment drainage.
 - d. Lab Waste and Vent lines which are located in return air plenums need to be insulated to meet the flame and smoke ratings associated with OBC building classifications and all NFPA requirements. Piping layouts are to be reviewed with OUA prior to final design and specifications.
2. Pipe insulation subject to water damage shall be covered with PVC or aluminum jacketing so insulation that may be subject to discharge from strainers, relief valves, automatic air vents or other drain taps is protected with the correct type of jacketing material based on type of discharge exposure.
3. Fiberglass Pipe Insulation
 - a. Encase exterior fiberglass piping insulation with aluminum jacket or PVC wrap with weatherproof construction. Insulation and jacketing systems specifically designed for outdoor or otherwise hazardous locations may be considered. Review with OUA.

- b. Pipe insulation exposed to blow down, strainer discharge or rain via tunnel entrance shall be covered with PVC jacket or aluminum jacket to a weather proof condition.
- 4. All insulation thicknesses and densities shall be selected to meet or exceed the energy reductions of current House Bill 251 and ASHRAE 90.1 and utilize ecologically friendly technology when possible. Review with the OUA.

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only items relevant to project.

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. Stainless-steel piping
4. PEX-Type A(Crosslinked) tube and fittings.
5. Piping joining materials.
6. Encasement for piping.
7. Transition fittings.
8. Dielectric fittings.

- B. Related Requirements:

Retain only items relevant sections to project.

1. Section 221113 "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

Delete below if no welding. AWS states that welding certificates remain in effect indefinitely unless welding personnel have not welded for more than six months or there is a specific reason to question their ability.

1.3 QUALITY ASSURANCE

- A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
- C. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. To comply with "Reduction of Lead in Drinking Water Act" all pipe, fixtures, and fitting used to convey water for potable use shall contain less than 0.25% of lead by weight.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.5 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.6 REGULATORY REQUIREMENTS

- A. ASME B 31.9 "Building Services Piping" for materials, products and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
- B. ASME "Boiler and Pressure Vessel Code" Section IX, "Welding and Brazing Qualification" for Qualifications for Welding Processes and Operators.
- C. OBC Ohio Building Plumbing Code.

1.7 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- G. Copper, Brass, or Bronze Pressure-Seal-Joint Fittings:
 - 1. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
 - 2. Minimum 200-psig working-pressure rating at 250 deg F.
- H. Appurtenances for Grooved-End Copper Tubing:
 - 1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze castings.
 - 2. Mechanical Couplings for Grooved-End Copper Tubing:
 - a. Copper-tube dimensions and design similar to AWWA C606.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating: 300 psig.

2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe:
 - 1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Standard-Pattern, Mechanical-Joint Fittings:
 - 1. AWWA C110/A21.10, ductile or gray iron.

2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Compact-Pattern, Mechanical-Joint Fittings:
 1. AWWA C153/A21.53, ductile iron.
 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. Push-on-Joint, Ductile-Iron Pipe:
 1. AWWA C151/A21.51.
 2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- E. Standard-Pattern, Push-on-Joint Fittings:
 1. AWWA C110/A21.10, ductile or gray iron.
 2. Gaskets: AWWA C111/A21.11, rubber.
- F. Compact-Pattern, Push-on-Joint Fittings:
 1. AWWA C153/A21.53, ductile iron.
 2. Gaskets: AWWA C111/A21.11, rubber.
- G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.
- H. Appurtenances for Grooved-End, Ductile-Iron Pipe:
 1. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
 2. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
 - a. AWWA C606 for ductile-iron-pipe dimensions.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating:
 - 1) NPS 14 to NPS 18: 250 psig.
 - 2) NPS 20 to NPS 46: 150 psig.

2.4 STAINLESS-STEEL PIPING

- A. Potable-water piping and components shall comply with NSF 61 Annex G.
- B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 10 and Schedule 40.
- C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.
- D. Appurtenances for Grooved-End, Stainless-Steel Pipe:
 1. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.

2. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:

- a. AWWA C606 for stainless-steel-pipe dimensions.
- b. Stainless-steel housing sections.
- c. Stainless-steel bolts and nuts.
- d. EPDM-rubber gaskets suitable for hot and cold water.
- e. Minimum Pressure Rating:
 - 1) NPS 8 and Smaller: 600 psig.
 - 2) NPS 10 and NPS 12: 400 psig.
 - 3) NPS 14 to NPS 24: 250 psig.

2.5 PEX Type A (Crosslinked) TUBE AND FITTINGS

- A. Tube Material: PEX plastic according to ASTM F 876 and ASTM F 877.
- B. Fittings: ASTM F 1807, metal insert and copper crimp rings.
- C. Fittings: ASSE 1061, push-fit fittings.
- D. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 876; with plastic or corrosion-resistant-metal valve for each outlet.

2.6 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.7 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.

2.8 TRANSITION FITTINGS

- A. General Requirements:

1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.9 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:
1. Standard: ASSE 1079.
 2. Pressure Rating: 125 or 250 psig (minimum working pressure as required to suit system pressures) at 180 deg F.
 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- D. Dielectric Flanges:
1. Standard: ASSE 1079.
 2. Factory-fabricated, bolted, companion-flange assembly.
 3. Pressure Rating: 125 or 250 psig (minimum working pressure as required to suit system pressures) at 180 deg F.
 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- E. Dielectric-Flange Insulating Kits:
1. Nonconducting materials for field assembly of companion flanges.
 2. Pressure Rating: 150 or 300 psig (minimum working pressure as required to suit system pressures).
 3. Gasket: Neoprene or phenolic.
 4. Bolt Sleeves: Phenolic or polyethylene.
 5. Washers: Phenolic with steel backing washers.
- F. Dielectric Nipples:
1. Standard: IAPMO PS 66.
 2. Electroplated steel nipple complying with ASTM F 1545.
 3. Pressure Rating and Temperature: 300 psig at 225 deg F.
 4. End Connections: Male threaded or grooved.
 5. Lining: Inert and noncorrosive, propylene.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

- H. Dielectric Waterways: Copper silicon casting conforming to UNS C87850 with grooved and/or threaded ends. Shall meet low-lead requirement of NSF-372.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping to permit valve servicing.
- L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install PEX tubing with loop at each change of direction of more than 90 degrees.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- R. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- W. Install check valves on hot and cold water supplies to mop basins and mixing valves.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- H. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- J. Joints for PEX Tubing: Join according to ASTM F 1807 for metal insert and copper crimp ring fittings and ASTM F 1960 for cold expansion fittings and reinforcing rings.
- K. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
- C. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
- D. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- E. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

- F. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

Retain first paragraph below if Project is in a seismic area.

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.

6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

- J. Install supports for vertical stainless steel piping every 15 feet.
- K. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least three days before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

- 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- #### A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K; copper pressure-seal fittings; and pressure-sealed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 - 2. Mechanical-joint, ductile-iron pipe; standard or compact-pattern, mechanical-joint fittings; and mechanical joints.
 - 3. Push-on-joint, ductile-iron pipe; standard or compact-pattern, push-on-joint fittings; and gasketed joints.
 - 4. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
 - 1. Mechanical-joint, ductile-iron pipe; standard or compact-pattern, mechanical-joint fittings; and mechanical joints.
 - 2. Push-on-joint, ductile-iron pipe; standard or compact-pattern, push-on-joint fittings; and gasketed joints.
 - 3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- G. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- H. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 3. Hard copper tube, ASTM B 88, Type L; copper push-on-joint fittings; and push-on joints.
 - 4. PEX tube, NPS 1 and smaller.
 - a. Fittings for PEX tube:
 - 1) ASTM F 1807, metal insert and copper crimp rings.
 - 2) ASTM F 1960, cold expansion fittings and reinforcing rings.
 - 3) ASSE 1061, push-fit fittings.

- I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 3. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
- J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
 - 3. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.
- K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
 - 1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
 - 2. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Domestic Water Systems and Components shall be furnished Lead Free up to weighted average 0.25% for wetted surfaces. Variance shall be reviewed by OUA.

- C. System purging and disinfecting activities report. Any discharge greater than 6 gpm, the contractor shall obtain a temporary discharge permit from City of Kent prior to purging the plumbing system. Contractor to coordinate with KSU OUA.
- D. Install type L copper with wrought copper fittings on domestic water lines 3" and smaller. Piping 2" and smaller shall have wrought copper fittings with 95-5 tin antimony solder. 2½" and 3" copper piping shall use wrought copper fittings with Silfos 7 silver solder.
- E. Install type K copper pipe for all domestic water piping below grade. Where joints below grade are unavoidable, the joints shall be made with silver solder.

Review with OUA and edit below accordingly

- F. There shall be no pro-press or grooved piping connections in concealed spaces, above rigid ceilings or in concealed chases or shafts. This type of fitting can only be installed in accessible locations or above a lay-in ceiling. **Do not install this type of fittings above 2-1/2" diameter without authorization from the OUA.** All piping within mechanical, electrical or tele/data shall be soldered, brazed or welded. Screwed or flanged shall be reviewed with OUA.
- G. All pipe penetration through concrete or any building structure above grade shall be isolated with Armaflex type insulation and sleeve as appropriate.
- H. All pipe penetrations through concrete or any building structure below grade shall be isolated with Flexcraft wall sleeve (PVC or Galvanized), Proline Sleeve for poured concrete, and EPDM rubber links, Link-Seal, Westatlantic, or approved equal. All concrete wall penetration sleeve shall have a puddle flange configuration.
- I. Drain valves shall be installed at all low points in the system to facilitate drainage and shall incorporate minimum 3/4" threaded hose adapter with chained cap. Larger sizes shall be reviewed with OUA.
- J. Continuous insulation shall be provided on all "Cold" water piping systems.

END OF SECTION 221116

KSU DESIGNERS NOTES:

- A. **Coordinate 4" and above piping materials with OUA.**
- B. **Mechanical coupling systems shall be coordinated with OUA. There shall be no pro-press or grooved piping connections in concealed spaces, above rigid ceilings or in concealed chases or shafts. This type of fitting can only be installed in accessible locations or above a lay-in ceiling. Do not install this type of fittings above 2-1/2" diameter without authorization from the OUA (adjust supplemental notes above accordingly). All piping within mechanical, electrical or tele/data shall be soldered, brazed or welded. Screwed or flanged shall be reviewed with OUA.**
- C. **Considerations shall be given to future alterations and expansion of the system; i.e. oversizing lines or providing capped branches for future connections.**

- D. Whenever possible, the domestic water piping shall be designed and installed in public areas such as over corridors and shafts. Avoid electrical, tele/data, elevator, computer classrooms, or research areas unless piping systems serve the area.
- E. Isolation valves shall be installed on all fixture groups and main branch lines. All domestic water valves shall be full port on 2½" and smaller. Apollo, Milwaukee or Hammond as manufacturers. (Review isolation valve requirements with OUA prior to final design.) There shall be NO combined water service which cannot be isolated with valves to separate bathroom groups. Each remote fixture shall be provided with isolation ball valve of any main or branch circuit. Plumbing fixtures shall have independent isolation valves by type or group but not more than 4 fixtures in any one group. Men's or woman's toilet groups shall have separate feeds so not more than one toilet room is required to be shut down if fixture and branch lines develops a leak.
- F. Isolation valves shall be installed on all equipment, and shall be installed to sectionalize any system by floor or wing. Review maintenance isolation and drain location requirements with OUA.
- G. Do not install grooved or press fittings above 2-1/2" diameter without authorization from the OUA.

SITE WATER SERVICE PIPING

- H. Site, Plumbing or Fire Protection Contractor as outline in note I shall install water service piping from 5' outside the building to utility connection. All services shall be coordinated with all other Prime Contractors and Local Authorities Having Jurisdiction (AHJ). Design documents will require that each campuses water provider be coordinated and that their installation guidelines and incorporate recommendations into the design documents. Review associated tap in fees are to be paid by contractor. On combination systems, contract documents are to have notes coordinating this process between the plumbing inspector, state fire marshal and water department purveyor. Fire line inspections shall be coordinated and called for by KSU-OUA. Contract documents shall clearly indicate that under NO conditions shall the contractor contact the state fire marshal direct. All contact and coordination is to go through KSU-OUA project manager.
- I. Review building service piping with plumbing, fire protection and civil drawings in construction documents from point of service regardless of the plumbing code reference to 5' outside the building. The Fire Protection contractor shall install combination water services. Civil or Plumbing Contractor can perform work but shall hire fire protection contractor to install combination domestic/fire water service. If civil or plumbing contractor has a licensed fire suppression installer, they can perform this type of work. Associates will need to vet out contractor prior to allowing them to perform installation.
- J. Installations of combination water/fire services the fire protection contractor shall perform the installation with approval from water purveyor to a point inside of the building, which subdivides services between fire and potable water system. Use and applications of Post indicator valves need reviewed with OUA and local fire department having jurisdiction. Plumbing contractor shall connect at subdivision within the building complex. All deviations from this shall be coordinated with the OUA.

- K. Provide fire lines off service mains with post indicator valve and tamper switch, thrust restrains, and backflow. Review submittals with OUA and AHJ. Fire department connections shall have Stortz connection with Knox Box. Review Knox Box requirements with OUA.**
- L. Water service piping from 5' outside the building to utility connection shall be installed by Site Contractor and coordinated with all Prime Contractors.**
- 1. The building water service piping starting at 5' outside the building shall be installed by the Plumbing Contractor or Fire Protection contractor if service is for a combination service. Civil Contractor can perform work but shall hire fire protection contractor to install fire or combination domestic/fire water service. If civil contractor is also a licensed fire suppression installer they will be allowed to perform this type of work. Associates will need to vet out contractor prior to allowing them to perform installation.**
 - 2. When combination water/fire services are installed the fire protection contractor shall install from water purveyor to inside of the building to subdivision between fire and potable water system. Use of Post indicator valves shall be reviewed with OUA and local fire department having jurisdiction. Plumbing contractor shall connect at subdivision within the building complex. All deviations from this shall be coordinated with the OUA.**
- M. General Installation Requirements:**
- 1. Wherever possible, make the water service connection to KSU master meter system. When not possible or if project is located at one of the regional campuses, the Associate shall comply with the local codes and requirements. Installation depth of water mains shall be 5'-0" below finished grade unless special written approval by OUA.**
 - 2. Water meters with BAS communication are required on all systems to allow water conservation efforts. Sub-meter all cooling tower make-up or outdoor water features to allow sewer rate deduct billing. Coordinate meter types and options required for communication with the Johnson Controls Metasys Automation System. Typically, Neptune turbine temperature compensated to read in cubic feet with TRI-CON E3 Reader is to be furnished on the Kent Campus. Meter types at all regionals shall be coordinated with local water purveyor and OUA.**
- N. Provide a standard clockwise-to-close curb stop at the connection to the street main.**
- O. Plans shall include a grade profile of the water line to insure adequate coverage (5'-0" minimum). Design shall consider sloping for air and water drainage - coordinate with City of Kent or local authority.**
- P. City of Kent or other local authority's standard requirements shall be followed whenever possible. A meeting shall be arranged by the Associate between the City of Kent and local authorities.**

- Q. The installation of new piping shall follow the AWWA c651-14 disinfection of water mains and shall use the continuous feed method in the chlorination process. Testing and approval of the process shall be reviewed with the local water purveyor and AHJ.**
- R. Plans and specifications shall be submitted to the City of Kent Building Department or local authority for review prior to connection to local authorities Utilities (Domestic Water, Storm, and Sanitary). Provide reference set of drawings if connected to the KSU main distribution system. Send the final Reference set to the local authority or City of Kent at the same time as final approvals are submitted to the State of Ohio, Industrial Compliance Division.**
- S. The respective contractor shall pay for all tap-in fees and contact the local authorities or city for inspections of the water service line.**
- T. Utilization fees, excavation permits, etc., associated with the water service piping shall be paid for within the project budget.**
- U. Chlorination of domestic water mains at the Kent campus is by the City of Kent Water Department. Coordination and cleaning shall meet City of Kent's or other local authority's requirements. Chlorination taps are provided by the City of Kent with a minimum 2-week time duration. Water taps at regional campuses shall be coordinated with local water purveyor.**

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only items relevant to project.

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. Stainless-steel piping
4. PEX-Type A(Crosslinked) tube and fittings.
5. Piping joining materials.
6. Encasement for piping.
7. Transition fittings.
8. Dielectric fittings.

- B. Related Requirements:

Retain only items relevant sections to project.

1. Section 221113 "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

Delete below if no welding. AWS states that welding certificates remain in effect indefinitely unless welding personnel have not welded for more than six months or there is a specific reason to question their ability.

1.3 QUALITY ASSURANCE

- A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
- C. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. To comply with "Reduction of Lead in Drinking Water Act" all pipe, fixtures, and fitting used to convey water for potable use shall contain less than 0.25% of lead by weight.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.5 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.6 REGULATORY REQUIREMENTS

- A. ASME B 31.9 "Building Services Piping" for materials, products and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
- B. ASME "Boiler and Pressure Vessel Code" Section IX, "Welding and Brazing Qualification" for Qualifications for Welding Processes and Operators.
- C. OBC Ohio Building Plumbing Code.

1.7 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- G. Copper, Brass, or Bronze Pressure-Seal-Joint Fittings:
 - 1. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
 - 2. Minimum 200-psig working-pressure rating at 250 deg F.
- H. Appurtenances for Grooved-End Copper Tubing:
 - 1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze castings.
 - 2. Mechanical Couplings for Grooved-End Copper Tubing:
 - a. Copper-tube dimensions and design similar to AWWA C606.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating: 300 psig.

2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe:
 - 1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Standard-Pattern, Mechanical-Joint Fittings:
 - 1. AWWA C110/A21.10, ductile or gray iron.

2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Compact-Pattern, Mechanical-Joint Fittings:
 1. AWWA C153/A21.53, ductile iron.
 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. Push-on-Joint, Ductile-Iron Pipe:
 1. AWWA C151/A21.51.
 2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- E. Standard-Pattern, Push-on-Joint Fittings:
 1. AWWA C110/A21.10, ductile or gray iron.
 2. Gaskets: AWWA C111/A21.11, rubber.
- F. Compact-Pattern, Push-on-Joint Fittings:
 1. AWWA C153/A21.53, ductile iron.
 2. Gaskets: AWWA C111/A21.11, rubber.
- G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.
- H. Appurtenances for Grooved-End, Ductile-Iron Pipe:
 1. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
 2. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
 - a. AWWA C606 for ductile-iron-pipe dimensions.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating:
 - 1) NPS 14 to NPS 18: 250 psig.
 - 2) NPS 20 to NPS 46: 150 psig.

2.4 STAINLESS-STEEL PIPING

- A. Potable-water piping and components shall comply with NSF 61 Annex G.
- B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 10 and Schedule 40.
- C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.
- D. Appurtenances for Grooved-End, Stainless-Steel Pipe:
 1. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.

2. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:

- a. AWWA C606 for stainless-steel-pipe dimensions.
- b. Stainless-steel housing sections.
- c. Stainless-steel bolts and nuts.
- d. EPDM-rubber gaskets suitable for hot and cold water.
- e. Minimum Pressure Rating:
 - 1) NPS 8 and Smaller: 600 psig.
 - 2) NPS 10 and NPS 12: 400 psig.
 - 3) NPS 14 to NPS 24: 250 psig.

2.5 PEX Type A (Crosslinked) TUBE AND FITTINGS

- A. Tube Material: PEX plastic according to ASTM F 876 and ASTM F 877.
- B. Fittings: ASTM F 1807, metal insert and copper crimp rings.
- C. Fittings: ASSE 1061, push-fit fittings.
- D. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 876; with plastic or corrosion-resistant-metal valve for each outlet.

2.6 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.7 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.

2.8 TRANSITION FITTINGS

- A. General Requirements:

1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.9 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:
1. Standard: ASSE 1079.
 2. Pressure Rating: 125 or 250 psig (minimum working pressure as required to suit system pressures) at 180 deg F.
 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- D. Dielectric Flanges:
1. Standard: ASSE 1079.
 2. Factory-fabricated, bolted, companion-flange assembly.
 3. Pressure Rating: 125 or 250 psig (minimum working pressure as required to suit system pressures) at 180 deg F.
 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- E. Dielectric-Flange Insulating Kits:
1. Nonconducting materials for field assembly of companion flanges.
 2. Pressure Rating: 150 or 300 psig (minimum working pressure as required to suit system pressures).
 3. Gasket: Neoprene or phenolic.
 4. Bolt Sleeves: Phenolic or polyethylene.
 5. Washers: Phenolic with steel backing washers.
- F. Dielectric Nipples:
1. Standard: IAPMO PS 66.
 2. Electroplated steel nipple complying with ASTM F 1545.
 3. Pressure Rating and Temperature: 300 psig at 225 deg F.
 4. End Connections: Male threaded or grooved.
 5. Lining: Inert and noncorrosive, propylene.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

- H. Dielectric Waterways: Copper silicon casting conforming to UNS C87850 with grooved and/or threaded ends. Shall meet low-lead requirement of NSF-372.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping to permit valve servicing.
- L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install PEX tubing with loop at each change of direction of more than 90 degrees.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- R. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- W. Install check valves on hot and cold water supplies to mop basins and mixing valves.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- H. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- J. Joints for PEX Tubing: Join according to ASTM F 1807 for metal insert and copper crimp ring fittings and ASTM F 1960 for cold expansion fittings and reinforcing rings.
- K. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
- C. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
- D. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- E. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

- F. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

Retain first paragraph below if Project is in a seismic area.

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.

6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

- J. Install supports for vertical stainless steel piping every 15 feet.
- K. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least three days before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

- 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- #### A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K; copper pressure-seal fittings; and pressure-sealed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 - 2. Mechanical-joint, ductile-iron pipe; standard or compact-pattern, mechanical-joint fittings; and mechanical joints.
 - 3. Push-on-joint, ductile-iron pipe; standard or compact-pattern, push-on-joint fittings; and gasketed joints.
 - 4. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
 - 1. Mechanical-joint, ductile-iron pipe; standard or compact-pattern, mechanical-joint fittings; and mechanical joints.
 - 2. Push-on-joint, ductile-iron pipe; standard or compact-pattern, push-on-joint fittings; and gasketed joints.
 - 3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- G. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- H. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 3. Hard copper tube, ASTM B 88, Type L; copper push-on-joint fittings; and push-on joints.
 - 4. PEX tube, NPS 1 and smaller.
 - a. Fittings for PEX tube:
 - 1) ASTM F 1807, metal insert and copper crimp rings.
 - 2) ASTM F 1960, cold expansion fittings and reinforcing rings.
 - 3) ASSE 1061, push-fit fittings.

- I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 3. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
- J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
 - 3. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.
- K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
 - 1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
 - 2. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Domestic Water Systems and Components shall be furnished Lead Free up to weighted average 0.25% for wetted surfaces. Variance shall be reviewed by OUA.

- C. System purging and disinfecting activities report. Any discharge greater than 6 gpm, the contractor shall obtain a temporary discharge permit from City of Kent prior to purging the plumbing system. Contractor to coordinate with KSU OUA.
- D. Install type L copper with wrought copper fittings on domestic water lines 3" and smaller. Piping 2" and smaller shall have wrought copper fittings with 95-5 tin antimony solder. 2½" and 3" copper piping shall use wrought copper fittings with Silfos 7 silver solder.
- E. Install type K copper pipe for all domestic water piping below grade. Where joints below grade are unavoidable, the joints shall be made with silver solder.
- F. There shall be no pro-press or grooved piping connections in concealed spaces, above rigid ceilings or in concealed chases or shafts. This type of fitting can only be installed in accessible locations or above a lay-in ceiling. All piping within electrical or tele/data rooms shall be soldered, brazed or welded.
- G. All pipe penetrations through concrete or any building structure shall be isolated with Flexcraft wall sleeve (PVC or Galvanized), Proline Sleeve for poured concrete, and EPDM rubber links, Link-Seal, Westatlantic, or approved equal. All concrete wall penetration sleeve shall have a puddle flange configuration.
- H. Drain valves shall be installed at all low points in the system to facilitate drainage and shall incorporate minimum ¾" threaded hose adapter with chained cap. Larger sizes shall be reviewed with OUA.
- I. Continuous insulation shall be provided on all "Cold" water piping systems.

END OF SECTION 221116

KSU DESIGNERS NOTES:

- a. Coordinate 4" and above piping materials with OUA.
- b. Mechanical coupling systems shall be coordinated with OUA.
- c. Considerations shall be given to future alterations and expansion of the system; i.e. over sizing lines or providing capped branches for future connections.
- d. Whenever possible, the domestic water piping shall be designed and installed in public areas such as over corridors and shafts. Avoid electrical, tele/data, elevator, computer classrooms, or research areas unless piping systems serve the area.
- e. Isolation valves shall be installed on all fixture groups and main branch lines. All domestic water valves shall be full port on 2½" and smaller. Apollo, Milwaukee or Hammond as manufacturers. (Review isolation valve requirements with OUA prior to final design.) There shall be NO combined water service which cannot be isolated with valves to separate bathroom

groups. Each remote fixture shall be provided with isolation ball valve of any main or branch circuit. Plumbing fixtures shall have independent isolation valves by type or group but not more than 4 fixtures in any one group. Men's or woman's toilet groups shall have separate feeds so not more than one toilet room is required to be shut down if fixture and branch lines develops a leak.

- f. Isolation valves shall be installed on all equipment, and shall be installed to sectionalize any system by floor or wing. Review maintenance isolation and drain location requirements with OUA.
- g. Do not install grooved or press fittings above 2-1/2" diameter without authorization from the OUA.

SITE WATER SERVICE PIPING

- a. Water service piping from 5' outside the building to utility connection shall be installed by Site Contractor and coordinated with all Prime Contractors.
- b. The building water service piping starting at 5' outside the building shall be installed by the Plumbing Contractor or Fire Protection contractor if service is for a combination service. Civil Contractor can perform work but shall hire fire protection contractor to install fire or combination domestic/fire water service. If civil contractor is also a licensed fire suppression installer they will be allowed to perform this type of work. Associates will need to vet out contractor prior to allowing them to perform installation.
- c. When combination water/fire services are installed the fire protection contractor shall install from water purveyor to inside of the building to subdivision between fire and potable water system. Use of Post indicator valves shall be reviewed with OUA and local fire department having jurisdiction. Plumbing contractor shall connect at subdivision within the building complex. All deviations from this shall be coordinated with the OUA.
- d. Wherever possible, the water service connection shall be made to KSU master meter system. When not possible or if project is located at one of the regional campuses, the Associate shall comply with the local codes and requirements. Installation depth of water mains shall be 5'-0" below finished grade unless special written approval is given by OUA.
- e. Water meters with BAS communication are required on all systems to allow water conservation efforts. Sub-meter all cooling tower make-up or outdoor water features to allow sewer rate deduct billing. Coordinate meter types and options required for communication with the Johnson Controls Metasys Automation System. Typically, Neptune turbine temperature compensated to read in cubic feet with TRI-CON E3 Reader is to be furnished on the Kent Campus. Meter types at all regionals shall be coordinated with local water purveyor and OUA.
- f. A standard clockwise-to-close curb stop shall be provided at the connection to the street main.

- g. Plans shall include a grade profile of the water line to insure adequate coverage (5'-0" minimum). Design shall consider sloping for air and water drainage - coordinate with City of Kent or local authority.**
- h. City of Kent or other local authority's standard requirements shall be followed whenever possible. A meeting shall be arranged by the Associate between the City of Kent and local authorities.**
- i. Plans and specifications shall be submitted to the City of Kent Building Department or local authority for review when system is connected to local authorities Utilities (Domestic Water, Storm, and Sanitary). Provide reference set of drawings if connected to the KSU main distribution system. Reference set shall be sent to the local authority or City of Kent at the same time as final approvals are submitted to the State of Ohio, Industrial Compliance Division.**
- j. The respective contractor shall pay for all tap-in fees and contact the local authorities or city for inspections of the water service line.**
- k. Utilization fees, excavation permits, etc., associated with the water service piping shall be paid for within the project budget.**
- l. Chlorination of domestic water mains at the Kent campus is by the City of Kent Water Department. Coordination and cleaning shall meet City of Kent's or other local authority's requirements. Chlorination taps are provided by the City of Kent with a minimum 2-week time duration. Water taps at regional campuses shall be coordinated with local water purveyor.**

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only items relevant to project.

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Automatic water shutoff valves.
5. Balancing valves.
6. Temperature-actuated, water mixing valves.
7. Strainers.
8. Outlet boxes.
9. Hose stations.
10. Hose bibbs.
11. Wall hydrants.
12. Ground hydrants.
13. Post hydrants.
14. Drain valves.
15. Water-hammer arresters.
16. Air vents.
17. Trap-seal primer valves.
18. Trap-seal primer systems.
19. Flexible connectors.
20. Water meters.
21. Protective shielding guards.

- B. Related Requirements:

Retain only items relevant sections to project.

1. Section 220519 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
4. Section 224713 "Drinking Fountains" for water filters for water coolers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14.
- B. Comply with NSF 372 for low lead.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Standard: ASSE 1001.
 - 2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 3. Body: Bronze.
 - 4. Inlet and Outlet Connections: Threaded.
 - 5. Finish: Rough bronze or Chrome plated.
- B. Hose-Connection Vacuum Breakers:
 - 1. Standard: ASSE 1011.
 - 2. Body: Bronze, nonremovable, with manual drain.
 - 3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 4. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Standard: ASSE 1020.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 5 psig maximum, through middle third of flow range.
4. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers:

1. Standard: ASSE 1035.
2. Size: NPS 1/4 or NPS 3/8 matching faucet size.
3. Body: Bronze.
4. End Connections: Threaded.
5. Finish: Chrome plated.

2.4 BACKFLOW PREVENTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ames.
2. Conbraco.
3. Febco.
4. Watts Regulator Co.

B. Intermediate Atmospheric-Vent Backflow Preventers:

1. Standard: ASSE 1012.
2. Operation: Continuous-pressure applications.
3. Size: As noted on drawings.
4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Chrome plated.

C. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle third of flow range.
4. Size: As noted on drawings.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

- c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

D. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: 5 psig maximum, through middle third of flow range.
4. Size: As noted on drawings.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

E. Beverage-Dispensing-Equipment Backflow Preventers:

1. Standard: ASSE 1022.
2. Operation: Continuous-pressure applications.
3. Size: NPS 1/4 or NPS 3/8.
4. Body: Stainless steel.
5. End Connections: Threaded.

F. Dual-Check-Valve Backflow Preventers:

1. Standard: ASSE 1024.
2. Operation: Continuous-pressure applications.
3. Size: As noted on drawings.
4. Body: Bronze with union inlet.

G. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:

1. Standard: ASSE 1032.
2. Operation: Continuous-pressure applications.
3. Size: NPS 1/4 or NPS 3/8.
4. Body: Stainless steel.
5. End Connections: Threaded.

H. Double-Check, Detector-Assembly Backflow Preventers:

1. Standard: ASSE 1048 and is FM Global approved or UL listed.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 5 psig maximum, through middle third of flow range.
4. Size: As noted on drawings.
5. Body: Cast iron with interior lining that complies with AWWA C550 or that is FDA approved or Stainless steel.
6. End Connections: Flanged.
7. Configuration: Designed for horizontal, straight-through flow.

8. Accessories:

- a. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
- b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

I. Hose-Connection Backflow Preventers:

1. Standard: ASSE 1052.
2. Operation: Up to 10-foot head of water back pressure.
3. Inlet Size: NPS 1/2 or NPS 3/4.
4. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
5. Capacity: At least 3-gpm flow.

J. Backflow-Preventer Test Kits:

1. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Spence Engineering Co., Inc.
2. Spirex Sarco Co.
3. Watts Regulator Co.

B. Water Regulators:

1. Standard: ASSE 1003.
2. Pressure Rating: Initial working pressure of 150 psig.
3. Size: As noted on drawings.
4. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. Valves for Booster Heater Water Supply: Include integral bypass.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

C. Water-Control Valves:

1. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
2. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
3. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
 - a. Size: As noted on drawings.
 - b. Pattern: Globe-valve design.

- c. Trim: Stainless steel.
- 4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.6 AUTOMATIC WATER SHUTOFF VALVES

A. Standards: NSF 61 and NSF 372.

B. Shutoff Control Ball Valve:

- 1. Size: As noted on drawings.
- 2. Control Valve: Two-piece, full-port brass ball valve, MSS SP-110.
 - a. End Connections: Threaded, female.
 - b. Seats: PTFE.
 - c. O-Rings: FKM.
 - d. Stem: Low lead brass. Blowout proof.
 - e. CWP Rating: 600 psig.
- 3. Manual override control turn-knob for emergency operation of the valve.

C. Shutoff Control Butterfly Valve:

- 1. Size: As noted on drawings.
- 2. Compliance: MSS SP-67.
- 3. Full-port, epoxy-coated, ductile-iron lug body.
- 4. Seat: EPDM, minus 30 deg F to plus 250 deg F.
- 5. Face-to-Face Flange: ASME B16.5 flanges.
- 6. Disc Design: Floating stainless-steel dual shaft.
- 7. Disc Material: Iron nylon 11 or Stainless steel.
- 8. Locating Pin: Carbon steel.
- 9. Bushings: PTFE.
- 10. O-Rings: EPDM.
- 11. Ten position stop.
- 12. Manual override control turn-knob for emergency operation of the valve.

D. Clothes Washer Shutoff Control Valve: Two-way, four-port, low-zinc bronze alloy valve.

- 1. End Connections: Male hose connections, NPS 3/4.
- 2. Pressure Rating: 400 psi at 32 to 150 deg F.
- 3. Maximum Test Pressure: 1200 psig.
- 4. Stem Travel: 0.16 inch.
- 5. Maximum Temperature: 250 deg F.
- 6. Valve Stem: Burnished Type 303 stainless steel.
- 7. Valve Stem Packing: Double EPDM.
- 8. Valve Seat: Integral bronze.
- 9. Valve Disc and Plunger: EPDM.
- 10. Valve Spring: Stainless steel.
- 11. Hoses: Two, 9-inch steel braided.
- 12. Hose End Connections: One straight and one 90-degree elbow connection; both hoses.

13. Furnish with hammer arrestors.

E. Clothes Washer Shutoff Control Valve Actuator: Two position, drive closed, spring open.

1. Housing: High-temperature composite glass-filled nylon.
2. Connection to Valve: NPT female brass ring.
3. Electric Motor: Reversible, brushless, and synchronism, maintains constant control speed to keep the cycle time constant. Maximum stem output is force balance controlled with electronic shutoff when end travel is detected in both directions.
4. Maximum Working Force: 48 lbf.
5. Power Requirements:
 - a. Input Voltage: 24 V ac.
 - b. Frequency: 60 Hz.
6. Power Supply: 120-V ac to 24-V ac transformer with cord and plug.
7. Working Time: 90 seconds.
8. Duty Rating: 100 percent.
9. Travel: 0.16 inch.
10. Position Indicator: Standard.
11. Working Temperature: 40 to 120 deg F.
12. Conform to CE and ROHS requirements.

F. Water Main Shutoff Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, two way; fails open/open or closed/closed.

G. Domestic Water Heater Shutoff Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, two way; fails open/open or close/close.

2.7 BALANCING VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Autoflow.
2. Bell and Gossett.
3. Taco, Inc.

B. Copper-Alloy Calibrated Balancing Valves:

1. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
2. Body: Brass or bronze.
3. Size: Same as connected piping, but not larger than NPS 2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

C. Cast-Iron Calibrated Balancing Valves:

1. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
 2. Size: Same as connected piping, but not smaller than NPS 2-1/2.
- D. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- E. Memory-Stop Balancing Valves:
1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
 2. Pressure Rating: 400-psig minimum CWP.
 3. Size: NPS 2 or smaller.
 4. Body: Copper alloy.
 5. Port: Standard or full port.
 6. Ball: Chrome-plated brass.
 7. Seats and Seals: Replaceable.
 8. End Connections: Solder joint or threaded.
 9. Handle: Vinyl-covered steel with memory-setting device.

2.8 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:
1. Standard: ASSE 1017.
 2. Pressure Rating: 125 psig.
 3. Type: Thermostatically controlled, water mixing valve.
 4. Material: Bronze body with corrosion-resistant interior components.
 5. Connections: Threaded union inlets and outlet.
 6. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
- B. Primary, Thermostatic, Water Mixing Valves:
1. Standard: ASSE 1017.
 2. Pressure Rating: 125 psig minimum unless otherwise indicated.
 3. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
 4. Material: Bronze body with corrosion-resistant interior components.
 5. Connections: Threaded union inlets and outlet.
 6. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
- C. Manifold, Thermostatic, Water Mixing-Valve Assemblies:
1. Description: Factory-fabricated, exposed-mounted, thermostatically controlled, water mixing-valve assembly in two-valve parallel arrangement.
 2. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
 3. Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
 4. Small-Flow Parallel: Thermostatic, water mixing valve.

5. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
6. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
7. Pressure Rating: 125 psig minimum unless otherwise indicated.
8. Cabinet: Factory fabricated, stainless steel, for surfacemounting and with hinged, stainless-steel door.

D. Individual-Fixture, Water Tempering Valves:

1. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Body: Bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Inlets and Outlet: Threaded.
6. Finish: Rough or chrome-plated bronze.

E. Primary Water Tempering Valves:

1. Standard: ASSE 1017, thermostatically controlled, water tempering valve, listed as tempering valve.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Body: Bronze.
4. Temperature Control: Manual.
5. Inlets and Outlet: Threaded.

2.9 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.10 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Mounting: Recessed.
2. Material and Finish: Enameled-steel, epoxy-painted-steel, plastic, or stainless-steel box and faceplate.

3. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
4. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
5. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
6. Inlet Hoses: Two 60-inch-long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
7. Drain Hose: One 48-inch-long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes:

1. Mounting: Recessed.
2. Material and Finish: Stainless-steel box and faceplate.
3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
4. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.11 HOSE STATIONS

A. Single-Temperature-Water Hose Stations:

1. Standard: ASME A112.18.1.
2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
3. Hose-Rack Material: Stainless steel.
4. Body Material: Bronze.
5. Body Finish: Rough bronze.
6. Mounting: Wall, with reinforcement.
7. Supply Fittings: NPS 3/4 gate, globe, or ball valve and check valve and NPS 3/4 copper, water tubing. Omit check valve if check stop is included with fitting.
8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet long.
9. Nozzle: With hand-squeeze, on-off control.
10. Vacuum Breaker:
 - a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.

B. Hot- and Cold-Water Hose Stations:

1. Standard: ASME A112.18.1.
2. Faucet Type: Thermostatic mixing valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze with stainless-steel wetted parts.

6. Body Finish: Rough bronze or chrome plated.
7. Mounting: Wall, with reinforcement.
8. Supply Fittings: Two NPS 3/4 gate, globe, or ball valves and check valves and NPS 3/4 copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet long.
10. Nozzle: With hand-squeeze, on-off control.
11. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

2.12 HOSE BIBBS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Standard.
 2. Chicago Faucet Co.
 3. Kohler.
 4. Moen (commercial grades).
 5. Sloan.
 6. Zurn.
- B. Hose Bibbs:
 1. Standard: ASME A112.18.1 for sediment faucets.
 2. Body Material: Bronze.
 3. Seat: Bronze, replaceable.
 4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
 5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
 6. Pressure Rating: 125 psig.
 7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
 9. Finish for Service Areas: Chrome or nickel plated.
 10. Finish for Finished Rooms: Chrome or nickel plated.
 11. Operation for Equipment Rooms: Wheel handle or operating key.
 12. Operation for Service Areas: Wheel handle.
 13. Operation for Finished Rooms: Operating key.
 14. Include operating key with each operating-key hose bibb.
 15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.13 WALL HYDRANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Prier.
 2. Smith, (J.R.) Manufacturing Co.
 3. Wade.

4. Woodford.
5. Zurn Industries Inc., Hydromechanics Division.

B. Nonfreeze Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): One with each wall hydrant.

C. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Vacuum Breaker:
 - a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.
10. Operating Key(s): One with each wall hydrant.

D. Vacuum Breaker Wall Hydrants:

1. Standard: ASSE 1019, Type A or Type B.
2. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
3. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
4. Pressure Rating: 125 psig.
5. Operation: Loose key or wheel handle.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: NPS 1/2 or NPS 3/4.
8. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.14 GROUND HYDRANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Prier.
 2. Smith, (J.R.) Manufacturing Co.
 3. Wade.
 4. Woodford.
 5. Zurn Industries Inc., Hydromechanics Division.
- B. Nonfreeze Ground Hydrants:
1. Standard: ASME A112.21.3M.
 2. Type: Nonfreeze, concealed-outlet ground hydrant with box.
 3. Operation: Loose key.
 4. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
 5. Inlet: NPS 3/4.
 6. Outlet: Garden-hose thread complying with ASME B1.20.7.
 7. Drain: Designed with hole to drain into ground when shut off.
 8. Box: Standard pattern with cover.
 9. Box and Cover Finish: Rough bronze.
 10. Operating Key(s): One with each ground hydrant.
 11. Vacuum Breaker: ASSE 1011.

2.15 POST HYDRANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Prier.
 2. Smith, (J.R.) Manufacturing Co.
 3. Wade.
 4. Woodford.
 5. Zurn Industries Inc., Hydromechanics Division.
- B. Nonfreeze, Draining-Type Post Hydrants:
1. Standard: ASME A112.21.3M.
 2. Type: Nonfreeze, exposed-outlet post hydrant.
 3. Operation: Loose key.
 4. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
 5. Casing: Bronze with casing guard.
 6. Inlet: NPS 3/4.
 7. Outlet: Garden-hose thread complying with ASME B1.20.7.
 8. Drain: Designed with hole to drain into ground when shut off.
 9. Vacuum Breaker:
 - a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.

10. Operating Key(s): One with each loose-key-operation wall hydrant.

C. Freeze-Resistant Sanitary Yard Hydrants:

1. Standard: ASSE 1057, Type 5 for nondraining hydrants.
2. Operation: Wheel handle.
3. Head: Copper alloy, with pail hook.
4. Inlet: NPS 3/4-inch threaded inlet and inlet nozzle, galvanized-steel riser, and venturi.
5. Canister: Zinc-plated steel with atmospheric-vent device.
6. Vacuum Breaker:
 - a. Removable hose-connection backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.16 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.17 WATER-HAMMER ARRESTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. PPP, Inc. or approved equal.

B. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows.

3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.18 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.19 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Standard: ASSE 1018.
2. Pressure Rating: 125 psig minimum.
3. Body: Bronze.
4. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
5. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
6. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
2. Size: NPS 1-1/4 minimum.
3. Material: Chrome-plated, cast brass.

2.20 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Standard: ASSE 1044.
2. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
3. Cabinet: Surface-mounted steel box with stainless-steel cover.
4. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

- a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Vacuum Breaker: ASSE 1001.
6. Number Outlets: Four.
7. Size Outlets: NPS 1/2.

2.21 FLEXIBLE CONNECTORS

- A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.22 WATER METERS

- A. Displacement-Type Water Meters:
 1. Standard: AWWA C700.
 2. Pressure Rating: 150-psig working pressure.
 3. Body Design: Nutating disc; totalization meter.
 4. Registration: In gallons or cubic feet as required by utility company.
 5. Case: Bronze.
 6. End Connections: Threaded.
- B. Turbine-Type Water Meters:
 1. Standard: AWWA C701.
 2. Pressure Rating: 150 psig working pressure.
 3. Body Design: Turbine; totalization meter.
 4. Registration: In gallons or cubic feet as required by utility company.
 5. Case: Bronze.
 6. End Connections for Meters NPS 2 and Smaller: Threaded.
 7. End Connections for Meters NPS 2-1/2 and Larger: Flanged.
- C. Compound-Type Water Meters:
 1. Standard: AWWA C702.
 2. Pressure Rating: 150-psig working pressure.

3. Body Design: With integral mainline and bypass meters; totalization meter.
 4. Registration: In gallons or cubic feet as required by utility company.
 5. Case: Bronze.
 6. Pipe Connections: Flanged.
- D. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

2.23 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Buckaroos, Inc.
 - b. McGuire Manufacturing.
 - c. Plumberex Specialty Products, Inc.
 - d. Truebro.
 - e. Zurn Industries, LLC.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Truebro.
 - b. Zurn Industries, LLC.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Backflow Preventers: Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe

- diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.
- B. Water Regulators: Install with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- C. Water Control Valves: Install with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- D. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve and downstream from fire sprinkler system supply. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.
- E. Balancing Valves: Install in locations where they can easily be adjusted.
- F. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- G. Y-Pattern Strainers: For water, install on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- H. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- I. Hose Stations: Install with check stops or shutoff valves on inlets and with thermometer on outlet.
1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- J. Ground Hydrants: Install with 1 cu. yd. of crushed gravel around drain hole. Set ground hydrants with box flush with grade.
- K. Nonfreeze, Draining-Type Post Hydrants: Install with 1 cu. yd. of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. of concrete block at grade.
- L. Freeze-Resistant Sanitary Yard Hydrants: Set with riser pipe in concrete or pavement. Do not encase canister in concrete.
- M. Water-Hammer Arresters: Install in water piping according to PDI-WH 201.
- N. Air Vents: Install vents at high points of water piping. Install drain piping and discharge onto floor drain.

- O. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- P. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- Q. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.
- C. Comply with requirements for grounding equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principle backflow preventers.
 - 4. Double-check, backflow-prevention assemblies.
 - 5. Carbonated-beverage-machine backflow preventers.
 - 6. Dual-check-valve backflow preventers.
 - 7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
 - 8. Double-check, detector-assembly backflow preventers.
 - 9. Water pressure-reducing valves.
 - 10. Automatic water shutoff valves.
 - 11. Calibrated balancing valves.
 - 12. Primary, thermostatic, water mixing valves.
 - 13. Manifold, thermostatic, water mixing-valve assemblies.
 - 14. Photographic-process, thermostatic, water mixing-valve assemblies.
 - 15. Primary water tempering valves.
 - 16. Outlet boxes.
 - 17. Hose stations.
 - 18. Supply-type, trap-seal primer valves.
 - 19. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to

identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check, backflow-prevention assembly, and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Pressure Regulating Valves: Equipment must be labeled with Design Pressures. Include pressure gauges upstream and downstream of device.
- C. Meters:
 - 1. Water Meters (Kent Main Campus): Neptune "Tri-Con E3" and City of Kent's Remote Reader device shall be required if direct connection to water service on city's mains. Read in Gallons per Cubic Feet and communicate with a 4-20 ma signal with reader connected to building BAS. Tri-Con meter shall be connected to building BAS.
 - 2. Water Meters (Regional Campus): Must be coordinated with the local water utility and the OUA and water meter or flow device shall be installed so flow meter or meter can communicate with the BAS.
- D. Backflow Preventors:

1. A funnel and drain line shall be attached to the relief port of the backflow preventer, full size and routed and safe wasted into the floor drain.
 2. Reduced pressure backflow preventers shall be installed on all makeup water lines to mechanical equipment.
 3. The reduced pressure backflow assembly shall be tested and a certificate of approval inserted in a vinyl sleeve and supported from the device or mounted on the wall nearby. Copies shall be furnished to local and or state authorities as required.
- E. Basket Strainers:
1. Screens shall be removed, cleaned and reinstalled prior to project closeout.
 2. Strainer screens to be stainless steel.
- F. Water Hammer Arresters:
1. Shall be installed in an accessible location and provide an isolation valve.
 2. Shall be installed at all major fixture groupings and wherever there is a potential for water hammer.
 3. Inverted air tube not acceptable.
- G. Exterior Wall Hydrants:
1. All exterior wall hydrants shall be non-freeze type and include anti-siphon device.
- H. Dielectrics Fittings:
1. Watts or approved equal.
 2. Required at all dissimilar metal waterway connections on domestic water systems.
 3. Bronze or brass valve is an acceptable dielectric.
- I. Y-Pattern Strainers:
1. Permanent strainer screens shall be of stainless steel construction.
 2. Strainers 6" and above shall also be furnished with steel start up screens.
 3. Complete installation with nipple, ball valve with hose threads connection cap and chain.
- J. Relief Valves:
1. Watts regulator or approved equal.
 2. Relief valves shall be piped to discharge in a floor drain with only one elbow. If more than one elbow is required, a union shall be installed close to the valve to facilitate easy replacement. In no cases shall there be more than three elbows from valve to point of discharge.
- K. Maintenance Stock: Furnish one valve key for each key operated hydrant, bibb, or faucet installed.

END OF SECTION 221119

KSU DESIGNERS NOTES:

1. Domestic hot water design – 140 deg F water heater temperature with 125 deg F delivery temperature.
2. Spence Engineering is the preferred manufacturer for domestic water pressure regulating valves.
3. Water Meters (Kent Main Campus): Neptune “Tri-Con E3” and City of Kent’s Remote Reader device shall be required if direct connection to water service on city’s mains. Read in Gallons per Cubic Feet and communicate with a 4-20 ma signal with reader connected to building BAS. Tri-Con meter shall be connected to building BAS.
4. Water Meters (Regional Campus): Must be coordinated with the local water utility and the OUA and water meter or flow device shall be installed so flow meter or meter can communicate with the BAS.
5. Water “deduct” meters shall be installed on all cooling tower make-up service lines or lawn irrigation, fountains or service in which the water is not discharged into sanitary system. Remote reading features above apply.
6. Sub-metering to be reviewed with OUA.
7. Backflow Preventers:
 - a. Ames is the preferred manufacturer for the University.
 - b. Reduced pressure backflow preventers shall be installed on the incoming water service of all new buildings and installed on existing buildings whenever there is substantial work in the area of the service entrance. Analyze affect on existing pressures and review requirements before installation on existing systems with OUA. Provide parallel backflow preventers with 100% redundant capacity unless reviewed with OUA.
 - c. A funnel and drain line shall be attached to the relief port of the backflow preventer, full size and routed and safe wasted into the floor drain. Associate to determine if floor drain will accept discharge rate or extend to outside of building. Drainage layout shall be reviewed with OUA. Floor calculation shall be performed and evaluated by Associate so risk and be assessed by KSU.
 - d. A floor drain shall be installed near the water service entrance on all new installations or as directed by OUA.
 - e. Leak detection shall be located as directed by OUA and shall alarm through the JCI BAS. Coordinate requirements with OUA as they are not required in all projects.

SECTION 221123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Manual gas shutoff valves.
5. Motorized gas valves.
6. Pressure regulators.
7. Service meters.
8. Dielectric fittings.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings and meter bars.
6. Dielectric fittings.

- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
1. Shop Drawing Scale: 1/4 inch per foot.
 2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

Retain below if seismic restraints are required for project.

- C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of seismic restraints.
 2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. NFPA 54 – National Fuel Gas Code, for gas piping materials and components, gas-piping installations, inspection, testing and purging of gas piping systems.
- E. Ohio Building Mechanical Code and Related Codes (OBC)
- F. ANSI Z223.1/NFPA 54, ANSI/NFPA 70
- G. AGA/GPTC Guide
- H. All Installations shall also comply to PUCO standards.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 65 psig minimum unless otherwise indicated.
 - 3. Minimum Operating Pressure of Service Meter: 5 psig.
- B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.
- C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.
- D. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern. Threads to conform to ANSI B1.20.1.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 - 6. Mechanical Couplings:
 - a. Steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Steelbolts, washers, and nuts.

- d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
- 1. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 - 2. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.
 - 3. Striker Plates: Steel, designed to protect tubing from penetrations.
 - 4. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
 - 5. Operating-Pressure Rating: 5 psig.
- C. PE Pipe: ASTM D 2513, SDR 11.
- 1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 - 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 - 4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.

- f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
- 5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. PE body with molded-in, stainless-steel support ring.
 - b. Buna-nitrile seals.
 - c. Acetal collets.
 - d. Electro-zinc-plated steel stiffener.
- 6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Fiber-reinforced plastic body.
 - b. PE body tube.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Stainless-steel bolts, nuts, and washers.
- 7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Steelbolts, washers, and nuts.
 - d. Factory-installed anode for steel-body couplings installed underground.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

- 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
- 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
- 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
- 4. Corrugated stainless-steel tubing with polymer coating.
- 5. Operating-Pressure Rating: 0.5 psig.
- 6. End Fittings: Zinc-coated steel.
- 7. Threaded Ends: Comply with ASME B1.20.1.
- 8. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

- 1. Copper-alloy convenience outlet and matching plug connector.
- 2. Nitrile seals.
- 3. Hand operated with automatic shutoff when disconnected.
- 4. For indoor or outdoor applications.
- 5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

- F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 MANUAL GAS SHUTOFF VALVES

- A. Manufacturers: Subject to compliance with requirements, provide gas cocks and valves by one of the following:
1. DeZurik.
 2. Jenkins Brothers.
 3. Lunkenheimer Company.
 4. Nibco Inc,
 5. Stockham.
 6. Hammond.
 7. Milwaukee Valve.

- B. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- C. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- D. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- E. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
 - 1. Body: Bronze, complying with ASTM B 584.
 - 2. Ball: Chrome-plated brass.
 - 3. Stem: Bronze; blowout proof.
 - 4. Seats: Reinforced TFE; blowout proof.
 - 5. Packing: Separate packnut with adjustable-stem packing threaded ends.
 - 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 7. CWP Rating: 600 psig.
 - 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Body: Bronze, complying with ASTM B 584.
 - 2. Ball: Chrome-plated bronze.
 - 3. Stem: Bronze; blowout proof.
 - 4. Seats: Reinforced TFE; blowout proof.
 - 5. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 7. CWP Rating: 600 psig.
 - 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
 2. Ball: Chrome-plated bronze.
 3. Stem: Bronze; blowout proof.
 4. Seats: Reinforced TFE.
 5. Packing: Threaded-body packnut design with adjustable-stem packing.
 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. CWP Rating: 600 psig.
 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
 2. Plug: Bronze.
 3. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Operator: Square head or lug type with tamperproof feature where indicated.
 5. Pressure Class: 125 psig.
 6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- I. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A 126, Class B.
 2. Plug: Bronze or nickel-plated cast iron.
 3. Seat: Coated with thermoplastic.
 4. Stem Seal: Compatible with natural gas.
 5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 6. Operator: Square head or lug type with tamperproof feature where indicated.
 7. Pressure Class: 125 psig.
 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- J. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A 126, Class B.
 2. Plug: Bronze or nickel-plated cast iron.
 3. Seat: Coated with thermoplastic.
 4. Stem Seal: Compatible with natural gas.
 5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 6. Operator: Square head or lug type with tamperproof feature where indicated.

7. Pressure Class: 125 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

K. PE Ball Valves: Comply with ASME B16.40.

1. Body: PE.
2. Ball: PE.
3. Stem: Acetal.
4. Seats and Seals: Nitrile.
5. Ends: Plain or fusible to match piping.
6. CWP Rating: 80 psig.
7. Operating Temperature: Minus 20 to plus 140 deg F.
8. Operator: Nut or flat head for key operation.
9. Include plastic valve extension.
10. Include tamperproof locking feature for valves where indicated on Drawings.

L. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.6 MOTORIZED GAS VALVES

A. Automatic Gas Valves: Comply with ANSI Z21.21.

1. Body: Brass or aluminum.
2. Seats and Disc: Nitrile rubber.
3. Springs and Valve Trim: Stainless steel.
4. Normally closed.
5. Visual position indicator.
6. Electrical operator for actuation by appliance automatic shutoff device.

B. Electrically Operated Valves: Comply with UL 429.

1. Pilot operated.
2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
6. NEMA ICS 6, Type 4, coil enclosure.
7. Normally closed.
8. Visual position indicator.

2.7 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure Protection Device: Factory mounted on pressure regulator.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure Protection Device: Factory mounted on pressure regulator.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 5 psig.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.

4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: 1 psig.

2.8 SERVICE METERS

A. Diaphragm-Type Service Meters: Comply with ANSI B109.1.

1. Case: Die-cast aluminum.
2. Connections: Steel threads.
3. Diaphragm: Synthetic fabric.
4. Diaphragm Support Bearings: Self-lubricating.
5. Compensation: Continuous temperature and pressure.
6. Meter Index: Cubic feet.
7. Meter Case and Index: Tamper resistant.
8. Remote meter reader compatible.
9. Maximum Inlet Pressure: 100 psig.
10. Pressure Loss: Maximum 0.5-inch wg.
11. Accuracy: Maximum plus or minus 1.0 percent.

B. Rotary-Type Service Meters: Comply with ANSI B109.3.

1. Case: Extruded aluminum.
2. Connection: Flange.
3. Impellers: Polished aluminum.
4. Rotor Bearings: Self-lubricating.
5. Compensation: Continuous temperature and pressure.
6. Meter Index: Cubic feet.
7. Tamper resistant.
8. Remote meter reader compatible.
9. Maximum Inlet Pressure: 100 psig.
10. Accuracy: Maximum plus or minus 2.0 percent.

C. Turbine Meters: Comply with ASME MFC-4M.

1. Housing: Cast iron or welded steel.
2. Connection Threads or Flanges: Steel.
3. Turbine: Aluminum or plastic.
4. Turbine Bearings: Self-lubricating.
5. Compensation: Continuous temperature and pressure.
6. Meter Index: Cubic feet.
7. Tamper resistant.
8. Remote meter reader compatible.
9. Maximum Inlet Pressure: 100 psig.
10. Accuracy: Maximum plus or minus 2.0 percent.

D. Service-Meter Bars:

1. Malleable- or cast-iron frame for supporting service meter.
2. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
3. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

E. Service-Meter Bypass Fittings:

1. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
2. Integral ball-check bypass valve.

2.9 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.10 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective

jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Install fittings for changes in direction and branch connections.
- F. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe

with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 SERVICE-METER ASSEMBLY INSTALLATION

- A. Install service-meter assemblies aboveground, on concrete bases.
- B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
- C. Install strainer on inlet of service-pressure regulator and meter set.
- D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
- E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
- F. Install service meters downstream from pressure regulators.
- G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 2. Bevel plain ends of steel pipe.
 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.8 HANGER AND SUPPORT INSTALLATION

Retain below if seismic restraints are required on systems.

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements for pipe hangers and supports specified in Section 220529 "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.9 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.

- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (flat).
 - d. Color: Per Architect.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (flat).
 - d. Color: Per Architect.
 - 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd (flat).

d. Color: Per Architect.

- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psi, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.14 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be one of the following:

1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - 2. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - 2. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with steel welding fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.17 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG

- A. Aboveground Piping: Maximum operating pressure more than 5 psig.
- B. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.
- C. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with steel welding fittings and welded joints.
- D. Underground, below building, piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- E. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- F. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.18 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:
 - 1. PE valves.
 - 2. NPS 2 and Smaller: Bronze plug valves.
 - 3. NPS 2-1/2 and Larger: Cast-iron, lubricated plug valves.

3.19 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
 - 1. Bronze plug valve.
 - 2. Cast-iron, nonlubricated plug valve.

- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 - 1. Bronze plug valve.
 - 2. Cast-iron, nonlubricated plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Bronze plug valve.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Natural Gas valves shall be classified to meet Utility Service being provided. Gas Valves shall be UL, CSA and FM listed for pressure and classification being used. All valving shall meet ANSI Z21.21, AGA 3-88 and ANSI/ASME B16.33 for minimum rating of 150 PSIG on low pressure systems. If used on fire protection systems FM approval is required.
- C. Contractors shall also be (OQ Certified) by Dominion East Ohio Gas (DEOG) is Natural Gas supplier.
- D. Contractors shall be current in the Columbia Gas (Participating contractor program) if work is required on service lines associated with Columbia Gas.
- E. Factory Mutual Insurance.
 - 1. All high-pressure gas lines above 90 lbs. to be radio graphed socket welded systems, and report data submitted to the A/E. Gas valves and associated fittings shall be reviewed with OUA.
 - 2. Gas lines in building 1 psi or above and or 2" size to be welded using socket or butt fittings. Gas lines below this pressure and size may be threaded.
- F. All exterior piping and fittings shall be painted with one coat of primer and two coats of protective paint. Exposed high-pressure lines to be painted orange. Coordinate all colors with A/E and OUA.
- G. Provide dirt leg prior to any equipment connection.

END OF SECTION 231123

KSU DESIGNERS NOTES:

1. When gas service is to be extended into lab or classroom the room shall be provided with an emergency shutoff device at egress exit. Piping and valving shall be recessed into walls. Review the need for push button emergency shut-off with OUA.
2. Coordination and verification of all natural gas valves shall be done with the Utility Service Provider and OUA.

No master specification section is provided for Domestic Water Packaged Booster Pumps. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

PART 1 - GENERAL

- 1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- A. Aurora.
 - B. Canariis.
 - C. Delta-P.
 - D. Patterson Pump.
 - E. Quantum Flow.
 - F. Tigerflow.

PART 2 - PRODUCTS

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

4.2 KENT STATE REQUIREMENTS:

- A. Main headers shall be of stainless steel construction.
- B. Control panels shall be designed with BacNET IP interface so KSU is able to communicate with Johnson Controls Metasys system. Panel to be complete with HOA functions, dual control circuits and power distribution.
- C. Pumps shall be able to operate at low flow conditions without backpressure or hammering.

END OF SECTION 221123.13

KSU DESIGNERS NOTES:

- 1. Pumps shall be duplex and 100% redundant for both flow and pressure.**
- 2. All packages shall be provided with VFD of manufacturers indicated in design guide. Exceptions on VFD's shall be reviewed and approved by OUA.**

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. In-line, seal-less centrifugal pumps.

Retain below only if relevant to project.

- B. Related Requirements:

- 1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which pumps will be attached.
 - 2. Size and location of initial access modules for acoustical tile.
- B. Field quality-control reports.

1.5 PERFORMANCE REQUIREMENTS

- A. Hydraulic Institute Compliance: Design, manufacture and install plumbing pumps in accordance with "Hydraulic Institute Standards."

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. UL Compliance: UL 778 for motor-operated water pumps.
- D. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.
- E. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 IN-LINE, SEAL-LESS CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Taco.
 - 2. Bell & Gossett, ITT.
 - 3. Watts.
- B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, seal-less, overhung-impeller centrifugal pumps.
- C. Pump Construction:
 - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
 - 2. Minimum Working Pressure: 125 psig.
 - 3. Maximum Continuous Operating Temperature: 220 deg F.
 - 4. Casing: Bronze or Stainless steel, with threaded or companion-flange connections.
 - 5. Impeller: Plastic, composite or stainless steel.
 - 6. Motor: Single speed.

2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Mount pumps in orientation complying with manufacturer's written instructions.
- C. Pump Mounting:
 - 1. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.
 - 1. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.
- C. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:
 - 1. Section 220523 "Valves for Plumbing Piping."
 - 2. Install pressure gauge and snubber at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge taps where provided

or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.4 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.7 ADJUSTING

- A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Inline hot water circulators shall be of brass or stainless steel construction.

END OF SECTION 221123.21

KSU DESIGNERS NOTES:

1. Review other manufacturers with OUA.
2. In-line hot water circulators shall be continuous running. No timers or T-stats.
3. JCI Metasys shall only monitor "Pump Status".
4. Contractor shall provide balance reports for hot water circulation system at construction close-out.
5. Balance valves shall be field adjustable type.

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only items relevant to project.

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Stainless-steel drainage pipe and fittings. (Commercial Kitchens)
5. Ductile-iron pipe and fittings.
6. Copper tube and fittings.
7. PVC pipe and fittings.
8. Specialty pipe fittings.

- B. Related Requirements:

Retain only items relevant sections to project.

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Section 226600 "Chemical-Waste Systems for Laboratory Facilities" for chemical-waste and vent piping systems.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: For hub-less, single-stack drainage system. Include plans, elevations, sections, and details.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

1.7 WARRANTY

- A. Listed manufacturers to provide labelling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Waste, Force-Main Piping: 50 psig.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A74, Service class.
- B. Gaskets: ASTM C564, rubber.
- C. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A888 or CISPI 301.
- B. Single-Stack Aerator Fittings: ASME B16.45, hub-less, cast-iron aerator and deaerator drainage fittings.
- C. CISPI, Hubless-Piping Couplings:
 - 1. Standards: ASTM C1277 and CISPI 310.
 - 2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.
- B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.
- C. Steel Pipe Pressure Fittings:
 - 1. Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
 - 1. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A536 ductile-iron castings, ASTM A47/A47M malleable-iron castings, ASTM A234/A234M forged steel fittings, or ASTM A106/A106M steel pipes with dimensions matching ASTM A53/A53M steel pipe, and complying with AWWA C606 for grooved ends.

2. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.6 STAINLESS-STEEL DRAINAGE PIPE AND FITTINGS

- A. Description: Comply with requirements of ASME A112.3.1, drainage pattern.
- B. Material: Type 304 stainless steel.
- C. Pipe Construction: Seamless.
- D. Internal Sealing Rings: EPDM, marked or color coded for the application.
- E. Joints: Single or double, socket and spigot ends.

2.7 DUCTILE-IRON PIPE AND FITTINGS

- A. Ductile-Iron, Mechanical-Joint Piping:
 1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
 2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Ductile-Iron, Push-on-Joint Piping:
 1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
 2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 3. Gaskets: AWWA C111/A21.11, rubber.
- C. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.
- D. Ductile-Iron, Grooved-End Pipe Appurtenances:
 1. Grooved-End, Ductile-Iron Fittings: ASTM A536 ductile-iron castings, with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings, and complying with AWWA C606 for grooved ends.
 2. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.8 COPPER TUBE AND FITTINGS

- A. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B88, Type L and Type M, water tube, drawn temper.
- D. Soft Copper Tube: ASTM B88, Type L (ASTM B88M, Type B), water tube, annealed temper.
- E. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- G. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.9 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F656.
- E. Solvent Cement: ASTM D2564.

2.10 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 2. Unshielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C1173.

- b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. End Connections: Same size as and compatible with pipes to be joined.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
 - 2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
3. Shielded, Nonpressure Transition Couplings:
- a. Standard: ASTM C1460.
 - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. End Connections: Same size as and compatible with pipes to be joined.
4. Pressure Transition Couplings:
- a. Standard: AWWA C219.
 - b. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - c. Center-Sleeve Material: Manufacturer's standard.
 - d. Gasket Material: Natural or synthetic rubber.
 - e. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:
- 1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
 - 2. Insulating Material: Suitable for system fluid, pressure, and temperature.
 - 3. Dielectric Unions:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 125 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
 - 4. Dielectric Flanges:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 125 psig minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

5. Dielectric-Flange Insulating Kits:

a. Description:

- 1) Nonconducting materials for field assembly of companion flanges.
- 2) Pressure Rating: 150 psig.
- 3) Gasket: Neoprene or phenolic.
- 4) Bolt Sleeves: Phenolic or polyethylene.
- 5) Washers: Phenolic with steel backing washers.

6. Dielectric Nipples:

a. Description:

- 1) Standard: IAPMO PS 66.
- 2) Electroplated steel nipple.
- 3) Pressure Rating: 300 psig at 225 deg F.
- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

7. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

8. Dielectric Waterways: Copper silicon casting conforming to UNS C87850 with grooved and/or threaded ends. Shall meet low-lead requirement of NSF-372.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- Q. Install aboveground PVC piping according to ASTM D2665.
- R. Install underground PVC piping according to ASTM D2321.
- S. Install engineered soil and waste and vent piping systems as follows:
 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- T. Install underground, ductile-iron, force-main piping according to AWWA C600.
 1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 3. Install encasement on piping according to ASTM A674 or AWWA C105/A 21.5.
- U. Install force mains at elevations indicated.
- V. Plumbing Specialties:

Retain only items relevant to project.

1. Install backwater valves in sanitary waster gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

- W. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- X. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Z. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.
 - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- F. Join copper tube and fittings with soldered joints according to ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

- H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join according to ASTM D2855 and ASTM D2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

- 1. Install transition couplings at joints of piping with small differences in ODs.
- 2. In Waste Drainage Piping: Unshielded, nonpressure transition couplings.
- 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
- 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

- 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- 3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- 4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. Shutoff Valves:

- 1. Install shutoff valve on each sewage pump discharge.
- 2. Install gate or full-port ball valve for piping NPS 2-1/2 and smaller.
- 3. Install gate valve for piping NPS 3 and larger.

B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

C. Backwater Valves: Install backwater valves in piping subject to backflow.

- 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
- 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
- 3. Install backwater valves in accessible locations.
- 4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 - 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 - 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 2: 84 inches with 3/8-inch rod.
 2. NPS 3: 96 inches with 1/2-inch rod.
 3. NPS 4: 108 inches with 1/2-inch rod.
 4. NPS 6: 10 feet with 5/8-inch rod.
- K. Install supports for vertical stainless-steel piping every 10 feet.
- L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
 5. NPS 6: 10 feet with 5/8-inch rod.
 6. NPS 8: 10 feet with 3/4-inch rod.
- M. Install supports for vertical copper tubing every 10 feet.
- N. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- O. Install supports for vertical PVC piping every 48 inches.
- P. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor.
6. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hub-less-piping couplings; and coupled joints.
 3. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 6. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Stainless-steel pipe and fittings gaskets, and gasketed joints.
 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hub-less-piping couplings; and coupled joints.
 3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
 4. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; coupled joints.
 3. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
 3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- J. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:
1. Soft copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
 2. Ductile-iron, mechanical-joint piping and mechanical joints.
 3. Ductile-iron, push-on-joint piping and push-on joints.
 4. Ductile-iron, grooved-joint piping and grooved joints.
 5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 and larger shall be any of the following:

1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. PVC pipe and fittings shall not be utilized in return air spaces, unless specified with appropriate accessories for code compliance.
- C. Hubless Cast Iron Soil Piping:
1. Clamp-All brand, no-hub 4 band heavy duty couplings shall be used on all 2½" and larger sanitary piping, Huskey (or approved equal) Heavy Duty on piping 2½" and below. Min. of four band heavy duty shall be min. base of design.
 2. Bottom of all stacks greater than one story shall incorporate no hub pipe restraint fittings. Holdrite, Romac, Charlotte Pipe, Tyler Pipe or approved equal.

END OF SECTION 221316

KSU DESIGNERS NOTES:

1. **Drainage and Vent Pipe and Fittings:**
 - a. **PVC, Type DWV piping and fittings, ASTM D2665, with solvent cemented joints; DWV plastic fitting patterns shall conform to ASTM D3311. Solvent: ASTM D2564.**
 - b. **PVC pipe and fittings shall be used for above grade piping unless specifically approved by OUA. Can be used for vent system if not exposed to ceiling plenum system or passing through fire rated assembly.**
 - c. **DWV piping below grade 6-inch and larger, material type shall be coordinated with OUA.**
2. **The use of CPVC piping for hot water discharge into sanitary piping system shall be reviewed with OUA.**
3. **Review all storm drainage piping with OUA on materials.**
4. **Refer to local municipal details for piping installations.**

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Air-admittance valves.
4. Roof flashing assemblies.
5. Through-penetration firestop assemblies.
6. Miscellaneous sanitary drainage piping specialties.
7. FOG disposal systems.

- B. Related Requirements:

1. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
2. Section 334200 "Stormwater Conveyance" for storm drainage piping and piping specialties outside the building.

1.3 DEFINITIONS

- A. FOG: Fats, oils, and greases.

- B. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories for the following:

1. FOG disposal systems.

- B. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.
2. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For FOG disposal systems, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than 2 1-gal. bottles.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide air admittance valves, backwater valves, expansion joints, drains, and trap primers products by one of the following:
 - a. Jay R. Smith
 - b. PPP, Inc (trap primers)
 - c. Studer Inc. (air admittance valves)
 - d. Tyler Pipe; Subsidiary of Tyler Corporation
 - e. Wade Manufacturing Co.
 - f. Zurn Industries

2.2 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.3 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

1. Standard: ASME A112.14.1.
2. Size: Same as connected piping.
3. Body: Cast iron.
4. Cover: Cast iron with bolted or threaded access check valve.
5. End Connections: Hub and spigot or hub-less.
6. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
7. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. Size: Same as floor drain outlet.
2. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
3. Check Valve: Removable ball float.
4. Inlet: Threaded.
5. Outlet: Threaded or spigot.

C. Horizontal, Plastic Backwater Valves:

1. Size: Same as connected piping.
2. Body: PVC.
3. Cover: Same material as body with threaded access to check valve.
4. Check Valve: Removable swing check.
5. End Connections: Socket type.

2.4 CLEANOUTS

Select below from cast iron, stainless steel, or plastic cleanouts.

A. Cast-Iron Exposed Cleanouts:

1. Standard: ASME A112.36.2M.
2. Size: Same as connected drainage piping
3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
4. Closure: Countersunk or raised-head, brass or plastic plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
2. Size: Same as connected branch.
3. Type: Heavy-duty, adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: Spigot.
7. Closure: Brass plug with straight threads and gasket or plastic plug.
8. Adjustable Housing Material: Cast iron with setscrews or other device.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
4. Closure Plug:
 - a. Brass.
 - b. Countersunk head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
5. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
6. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

D. Stainless-Steel Exposed Cleanouts:

1. Standard: ASME A112.3.1.
2. Size: Same as connected drainage piping
3. Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
4. Closure: Stainless-steel plug with seal.

E. Stainless-Steel Exposed Floor Cleanouts:

1. Standard: ASME A112.3.1.
2. Size: Same as connected branch.
3. Housing: Stainless steel.
4. Closure: Stainless steel with seal.
5. Riser: ASTM A 74, Service class, stainless-steel drainage pipe fitting and riser to cleanout.
6. Body or Ferrule: Stainless steel.
7. Clamping Device: Not required.
8. Outlet Connection: Spigot.
9. Closure: Brass plug with straight threads and gasket.

10. Adjustable Housing Material: Cast iron with setscrews or other device.
11. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
12. Frame and Cover Shape: Round.
13. Top Loading Classification: Heavy Duty.

F. Plastic Floor Cleanouts:

1. Size: Same as connected branch.
2. Body: PVC.
3. Closure Plug: PVC.
4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.5 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
2. Housing: Plastic.
3. Operation: Mechanical sealing diaphragm.
4. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

1. Standard: ASSE 1050 for vent stacks.
2. Housing: Plastic.
3. Operation: Mechanical sealing diaphragm.
4. Size: Same as connected stack vent or vent stack.

C. Wall Box for Air-Admittance Valves:

1. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
2. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.6 ROOF FLASHING ASSEMBLIES (Maintain Roofing Warranty)

A. Roof Flashing Assemblies:

1. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.
 - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.7 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve-and-stack fitting with fire stopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hub-less-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.8 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.9 FOG DISPOSAL SYSTEMS

A. FOG Disposal Systems:

1. Standard: ASME A112.14.6, for removing solids from and breaking down and digesting suspended fats, oils, and greases from food-preparation wastewater.
2. Flow-Control Fitting: Matching unit size.
3. Strainer Unit: Stainless-steel housing with aluminum cover and removable-basket-type, stainless-steel, wire-mesh strainer. Include pressure plug instead of cover.
4. Media Chamber: Stainless-steel housing and aluminum cover, with internal baffles, piping, plastic coalescing surfaces, and clarifier section with test ports.
5. Shelf: Stainless steel, 19-1/2 inches wide by 13 inches high by 8-3/4 inches deep, for metering pump, control devices, and culture bottle.
6. Culture Metering Pump, Timer, Control, and Tubing: Proprietary.
7. Culture: Include 1-gal. bottle, as recommended by unit manufacturer.
8. Strainer and Media Chamber, Unit Size: 20 gpm.
9. Inlet and Outlet: NPS 2.
10. Strainer and Media-Chamber, Unit Size: 50 gpm.

11. Inlet and Outlet: NPS 3.
12. Piping: Waste and vent piping is specified in Section 221316 "Sanitary Waste and Vent Piping."

2.10 MOTORS

- A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, motor shall be large enough, so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment Mounting:

1. Install FOG disposal systems on cast-in-place concrete equipment base(s).
 - a. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration-isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
3. Comply with requirements for vibration-isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

- B. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

- F. Install fixture air-admittance valves on fixture drain piping.
- G. Install stack air-admittance valves at top of stack vent and vent stack piping.
- H. Install air-admittance-valve wall boxes recessed in wall.
- I. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- J. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- K. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping."
- L. Assemble open drain fittings and install with top of hub 1 inch above floor.
- M. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- N. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- O. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- P. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- Q. Install vent caps on each vent pipe passing through roof.
- R. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- S. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- T. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- U. Assemble components of FOG disposal systems and install on floor.
 - 1. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction.
 - 2. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated.
 - 3. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.

- V. Install wood-blocking reinforcement for wall-mounting-type specialties.
- W. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

- A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.
- C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- D. Set flashing on floors and roofs in solid coating of bituminous cement.
- E. Secure flashing into sleeve and specialty clamping ring or device.
- F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. FOG disposal systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
 - 1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections, and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and their installation, including piping and electrical connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 221319

KSU DESIGNERS NOTES:

1. Trap primers shall be flow type or electronic unless pressure drop can be designed into the system.
2. Sure Seal traps are acceptable with OUA approval in lieu of trap primers.
3. Coordinate flush with floor cleanout covers with floor finish.
4. Floor drains shall be furnished with protective covers during construction.
5. Floor drains to be installed in all public toilet rooms, all other toilet rooms' review with OUA.
6. Roof and floor drains shall be no smaller than 3" pipe size; floor drains in mechanical rooms shall be 4" minimum floor sink type. Mechanical room floor drains shall have grating cuts or funnels specified to allow drain piping to spill into floor drain with minimal splashing. Floor drain type of construction shall be specified to account for type of waste. Review material selection with OUA.

SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only items relevant to project.

1. Floor drains.
2. Floor sinks.
3. Trench drains.
4. Channel drainage systems.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. HDPE: High-density polyethylene.
- C. PE: Polyethylene.
- D. PP: Polypropylene.
- E. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide drain products by one of the following:

1. Jay R. Smith
2. Tyler Pipe; Subsidiary of Tyler Corporation
3. Wade Manufacturing Co.
4. Zurn Industries

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Standard: ASME A112.6.3 with backwater valve.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Required.
5. Anchor Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Backwater Valve: Integral, ASME A112.14.1, swing-check type.
9. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
10. Sediment Bucket: Required.
11. Top or Strainer Material: Nickel bronze.
12. Top of Body and Strainer Finish: Nickel bronze.
13. Top Shape: Square.
14. Top Loading Classification: Heavy Duty.
15. Funnel: Required.

B. Stainless-Steel Floor Drains, ASME A112.3.1:

1. Outlet: Bottom.
2. Top or Strainer Material: Stainless steel.
3. Top Shape: Round.
4. Seepage Flange: Required.
5. Anchor Flange: Required.
6. Clamping Device: Required.
7. Trap-Primer Connection: Required.
8. Trap Material: Stainless steel.
9. Trap Pattern: Standard P-trap.

C. Stainless-Steel Floor Drains, ASME A112.6.3:

1. Outlet: Bottom.
2. Top or Strainer Material: Stainless steel.
3. Top Shape: Round.
4. Seepage Flange: Required.
5. Anchor Flange: Required.
6. Clamping Device: Required.
7. Trap-Primer Connection: Not required.

8. Trap Material: Stainless steel.
9. Trap Pattern: Deep-seal P-trap.

2.4 FLOOR SINKS

A. Cast-Iron Floor Sinks:

1. Standard: ASME A112.6.7.
2. Pattern: Floor drain.
3. Body Material: Cast iron.
4. Anchor Flange: Required , with seepage holes.
5. Clamping Device: Required.
6. Outlet: Bottom, no-hub connection.
7. Coating on Interior Surfaces: Acid-resistant enamel.
8. Sediment Bucket: Required.
9. Internal Strainer: Not required Flat.
10. Internal Strainer Material: Aluminum.
11. Top Grate Material: Cast iron, hinged.
12. Top of Body and Grate Finish: Nickel bronze.
13. Top Shape: Square.
14. Top Loading Classification: No traffic.
15. Funnel: Required.

B. Stainless-Steel Floor Sinks, ASME A112.6.7:

1. Standard: ASME A112.6.7.
2. Pattern: Floor drain.
3. Body Material: Stainless steel.
4. Anchor Flange: Required, with seepage holes.
5. Clamping Device: Required.
6. Outlet: Bottom, no-hub connection.
7. Sediment Bucket: Required.
8. Internal Strainer: Flat.
9. Internal Strainer Material: Stainless steel.
10. Top Grate Material: Stainless steel, hinged.
11. Top of Body and Grate Finish: Stainless steel.
12. Top Shape: Square.
13. Top Loading Classification: No traffic.
14. Funnel: Required.

2.5 TRENCH DRAINS (Review with KSU OUA)

A. Trench Drains:

1. Standard: ASME A112.6.3 for trench drains.
2. Material: Ductile or gray iron.
3. Flange: Seepage.
4. Clamping Device: Required.
5. Outlet: Bottom.

6. Grate Material: Ductile iron.
7. Grate Finish: Painted.
8. Top Loading Classification: Heavy Duty.
9. Trap Material: Cast iron.
10. Trap Pattern: Standard P-trap.

2.6 CHANNEL DRAINAGE SYSTEMS

A. Stainless-Steel Channel Drainage Systems, ASME A112.3.1:

1. Description: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
2. Standard: ASME A112.3.1 for trench drains.
3. Channel Sections: Interlocking joint, stainless steel with level invert.
 - a. Dimensions: 5.8 inches or 11.7 inches wide. Include number of units required to form total lengths indicated.
4. Grates: Manufacturer's designation "heavy duty," with slots or perforations and of width and thickness that fit recesses in channels.
 - a. Material: Stainless steel.
 - b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
5. Covers: Solid stainless steel, of width and thickness that fit recesses in channels, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

B. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems:

1. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
2. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.
 - a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
 - b. Include extension sections necessary for required depth.
 - c. Dimensions: 4-inch inside width. Include number of units required to form total lengths indicated.
 - d. Frame: Gray-iron or galvanized steel for grates.
3. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - a. Material: Ductile iron.

- 1) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 4. Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 5. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- C. FRP Channel Drainage Systems:
1. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 2. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.
 - a. Dimensions: 4 or 6 inches wide. Include number of units required to form total lengths indicated.
 - b. Frame: Manufacturer's standard metal for grates.
 3. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
 - a. Material: Fiberglass or Stainless steel.
 - b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 4. Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 5. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- D. PP Channel Drainage Systems:
1. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 2. Channel Sections: Interlocking-joint, PP modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.
 - a. Dimensions: 4 inches wide. Include number of units required to form total lengths indicated.
 3. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
 - a. Material: Fiberglass or Stainless steel.

4. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
5. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install trench drains at low points of surface areas to be drained.
 1. Set grates of drains flush with finished surface, unless otherwise indicated.
- C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
 1. Install on support devices, so that top will be flush with adjacent surface.
- D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.
- E. Install open drain fittings with top of hub 1 inch above floor.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.
- D. Install piping adjacent to equipment to allow service and maintenance.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

END OF SECTION 221319.13

KSU DESIGNERS NOTES:

1. Floor drains shall be installed in all public toilet rooms, all other toilet rooms shall be reviewed with OUA.
2. Floor drains shall be no smaller than 3" pipe size; drains in mechanical rooms shall be minimum 4" floor sink type.
3. Mechanical room floor drains shall be have grating cuts or funnels specified to allow drain piping to spill into floor drain with minimal splashing.

4. Floor drain type of construction shall be specified to account for type of waste. Review material selection with OUA.
5. Above grade sanitary piping, trap, and drains having cold discharge shall be insulated including the branch line to the first vertical drops.

SECTION 221413 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only items relevant to project.

- 1. Hub-and-spigot, cast-iron soil pipe and fittings.
- 2. Hubless, cast-iron soil pipe and fittings.
- 3. Ductile-iron pipe and fittings.
- 4. PVC pipe and fittings.
- 5. Specialty pipe and fittings.
- 6. Encasement for underground metal piping.

- B. Related Requirements:

- 1. Section 221429 "Sump Pumps" for storm drainage pumps.
- 2. Section 334400 "Stormwater Utility Equipment" for storm drainage piping outside the building.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For siphonic roof drainage system. Include calculations, plans, and details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which drainage piping will be attached or suspended from.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of storm drainage service.
 - 2. Do not proceed with interruption of storm drainage service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Storm Drainage, Force-Main Piping: 50 psig.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings:
 - 1. Marked with CISPI collective trademark and NSF certification mark.
 - 2. Class: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.
- C. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Couplings shall bear CISPI collective trademark and NSF certification mark.
2. Standards: ASTM C 1277 and CISPI 310..
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.
2. Ductile-Iron, Grooved-End Pipe Appurtenances:
 - a. Grooved-End, Ductile-Iron Fittings: ASTM A 536, ductile-iron castings with dimensions matching AWWA C110/A21.10, ductile-iron pipe or AWWA C153/A21.53, ductile-iron fittings; complying with AWWA C606 for grooved ends.
 - b. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.5 PVC PIPE AND FITTINGS

- A. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665; drain, waste, and vent.
- C. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- D. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- E. Adhesive Primer: ASTM F 656.
- F. Solvent Cement: ASTM D 2564.

2.6 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
 - 3. Unshielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C 1173.
 - b. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 4. Shielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C 1460.
 - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. End Connections: Same size as and compatible with pipes to be joined.
 - 5. Pressure Transition Couplings:
 - a. Standard: AWWA C219.

- b. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
- c. Center-Sleeve Material: Manufacturer's standard.
- d. Gasket Material: Natural or synthetic rubber.
- e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

- 1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- 2. Insulating Material: Suitable for system fluid, pressure, and temperature.
- 3. Dielectric Unions:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
- 4. Dielectric Flanges:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- 5. Dielectric-Flange Insulating Kits:
 - a. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel-backing washers.
- 6. Dielectric Nipples:
 - a. Description: Electroplated steel nipple.
 - b. Standard: IAPMO PS 66.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.
- 7. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

8. Dielectric Waterways: Copper silicon casting conforming to UNS C87850 with grooved and/or threaded ends. Shall meet low-lead requirement of NSF-372.

2.7 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: High-density, cross laminated polyethylene film of 0.004-inch minimum thickness.
- C. Form: Sheet or tube.
- D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.

- J. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
 - 1. Do not change direction of flow more than 90 degrees.
 - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm Drainage Piping: 2 percent downward in direction of flow.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install aboveground PVC piping according to ASTM D 2665.
- O. Install underground PVC piping according to ASTM D 2321.
- P. Install engineered siphonic drain specialties and storm drainage piping in locations indicated.
- Q. Install underground, ductile-iron, force-main piping according to AWWA C600.
 - 1. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints.
 - 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- R. Install force mains at elevations indicated.
- S. Plumbing Specialties:
 - 1. Install backwater valves in storm drainage gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
3. Install drains in storm drainage gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
- T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors.
 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs.
 1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints:
 1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- E. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendices.

F. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
 - c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
4. In Underground Force-Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.
2. Install full port ball valve for piping NS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

B. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

C. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
 8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- K. Install supports for vertical PVC piping every 48 inches.
- L. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 2. Install horizontal backwater valves with cleanout cover flush with floor.
 3. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221423 "Storm Drainage Piping Specialties."
- D. Connect force-main piping to the following:
1. Storm Sewer: To exterior force main.
 2. Sump Pumps: To sump pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance.
- F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed storm drainage piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 3. Test Procedure:
 - a. Test storm drainage piping, except outside leaders, on completion of roughing-in.
 - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.
- C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow standing for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.
- D. Piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI, cast-iron, hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI, cast-iron, hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- F. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
1. Galvanized-steel pipe, pressure fittings, and threaded joints.
- G. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
1. Galvanized-steel pipe, pressure fittings, and threaded joints.
 2. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
 3. Fitting-type transition couplings if dissimilar pipe materials.
- H. Underground storm drainage force mains NPS 4 and smaller shall be any of the following:
1. Ductile-iron, mechanical-joint piping and mechanical joints.
 2. Ductile-iron, push-on-joint piping and push-on joints.
 3. Ductile-iron, grooved-joint piping and grooved joints.
 4. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.
- I. Underground storm drainage force mains NPS 5 and larger shall be any of the following:
1. Ductile-iron, mechanical-joint piping and mechanical joints.
 2. Ductile-iron, push-on-joint piping and push-on joints.
 3. Ductile-iron, grooved-joint piping and grooved joints.
 4. Pressure transition couplings if dissimilar pipe materials.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. PVC pipe and fittings shall not be utilized in return air spaces, unless specified with appropriate accessories for code compliance.

KSU DESIGNERS NOTES:**1. Drainage and Vent Pipe and Fittings:**

- a. PVC, Type DWV piping and fittings, ASTM D2665, with solvent cemented joints; DWV plastic fitting patterns shall conform to ASTM D3311. Solvent: ASTM D2564.
- b. PVC pipe and fittings shall be used for above grade piping unless specifically approved by OUA. Can be used for vent system if not exposed to ceiling plenum system or passing through fire rated assembly.
- c. DWV piping below grade 6-inch and larger, material type shall be coordinated with OUA.

END OF SECTION 221413

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

Retain only items relevant to project.

- A. Section Includes:

- 1. Metal roof drains.
- 2. Miscellaneous storm drainage piping specialties.
- 3. Cleanouts.
- 4. Backwater valves.
- 5. Trench drains.
- 6. Channel drainage systems.

- B. Related Requirements:

- 1. Section 076200 "Sheet Metal Flashing and Trim" for penetrations of roofs.
- 2. Section 078413 "Penetration Firestopping" for firestopping roof penetrations.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Jay R. Smith
- b. Tyler Pipe; Subsidiary of Tyler Corporation
- c. Wade Manufacturing Co.
- d. Zurn Industries

B. Cast-Iron, Large-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4.
2. Body Material: Cast iron.
3. Dimension of Body: Nominal 14-to 16-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Flow-Control Weirs: Required.
6. Outlet: Bottom.
7. Outlet Type: No hub.
8. Extension Collars: Required.
9. Underdeck Clamp: Required.
10. Expansion Joint: Not required.
11. Sump Receiver Plate: Required.
12. Dome Material: Cast iron.
13. Perforated Gravel Guard: Stainless steel.
14. Vandal-Proof Dome: Not required.
15. Water Dam: 2 inches high.

C. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4.
2. Body Material: Cast iron.
3. Dimension of Body: 8- to 12-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Flow-Control Weirs: Required.
6. Outlet: Bottom.
7. Outlet Type: No hub.
8. Extension Collars: Required.
9. Underdeck Clamp: Required.
10. Expansion Joint: Not required.
11. Sump Receiver Plate: Required.
12. Dome Material: Cast iron.
13. Wire Mesh: Stainless steel or brass over dome.
14. Perforated Gravel Guard: Stainless steel.
15. Vandal-Proof Dome: Not required.
16. Water Dam: 2 inches high..

D. Cast-Iron, Small-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4.
2. Body Material: Cast iron.
3. Dimension of Body: Nominal 8-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Outlet: Bottom.
6. Outlet Type: No hub.
7. Extension Collars: Required.
8. Underdeck Clamp: Required.
9. Expansion Joint: Not required.
10. Sump Receiver Plate: Required.
11. Dome Material: Cast iron.
12. Wire Mesh: Stainless steel or brass over dome.
13. Vandal-Proof Dome: Not required..

E. Metal, Medium-Sump, Deck Roof Drains:

1. Standard: ASME A112.6.4.
2. Body Material: Cast iron.
3. Flange: Anchor with weep holes.
4. Clamping Device: Required.
5. Integral Backwater Valve: Not required.
6. Outlet: Bottom.
7. Outlet Type: No hub.
8. Grate Material: Cast or ductile iron.
9. Grate Finish: Not required.
10. Overall Dimension of Frame and Grate: Nominal 12 to 14 inches round.
11. Top-Loading Classification: Heavy Duty.
12. Vandal-Proof Frame and Grate: Required..

F. Metal, Small-Sump, Deck Roof Drains:

1. Standard: ASME A112.6.4.
2. Body Material: Metal.
3. Flange: Anchor with weep holes.
4. Clamping Device: Required.
5. Integral Backwater Valve: Not required.
6. Outlet: Bottom.
7. Outlet Type: No hub.
8. Grate Material: Cast or ductile iron.
9. Grate Finish: Not required.
10. Overall Dimension of Frame and Grate: Nominal 8 inches round.
11. Top-Loading Classification: Heavy Duty.
12. Vandal-Proof Frame and Grate: Required.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.3 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Standard: ASME A112.36.2M.
2. Size: Same as connected branch.
3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
4. Closure: Countersunk, brass plug.
5. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Standard: ASME A112.36.2M.
2. Size: Same as connected branch.
3. Type: Adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: No hub.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with setscrews or other device.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
4. Closure Plug:

- a. Brass.
 - b. Countersunk head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as, or not more than, one size smaller than cleanout size.
5. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
 6. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

D. Test Tees:

1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure Plug: Countersunk, brass.
5. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

2.4 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves:

1. Standard: ASME A112.14.1.
2. Size: Same as connected piping.
3. Body Material: Cast iron.
4. Cover: Cast iron with bolted access check valve.
5. End Connections: Hub and spigot.
6. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
7. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Cast-Iron, Drain-Outlet Backwater Valves:

1. Standard: ASME A112.14.1.
2. Size: Same as floor drain outlet.
3. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.5 TRENCH DRAINS

A. Trench Drains:

1. Standard: ASME A112.6.3.
2. Body Material: Cast iron.
3. Flange: Anchor.

4. Clamping Device: Required.
5. Outlet: Bottom.
6. Outlet Type: Inside caulk.
7. Grate Material: Ductile iron or stainless steel.
8. Grate Finish: Not required.
9. Top-Loading Classification: Heavy Duty.

2.6 CHANNEL DRAINAGE SYSTEMS

A. Narrow, Sloped-Invert, Polymer-Concrete, Channel Drainage Systems:

1. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 - a. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.
 - 1) Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
 - 2) Include extension sections necessary for required depth.
 - 3) Dimensions: 5-inch inside width and 9-3/4-inch inside depth. Include number of units required to form total lengths indicated.
 - 4) Frame: Galvanized steel or cast iron for grates.
 - b. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - 1) Material: Ductile iron or Stainless steel.
 - 2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 - c. Covers: Solid ductile or cast iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 - d. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
 - e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

B. Narrow, Level-Invert, Polymer-Concrete, Channel Drainage Systems:

1. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 - a. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.
 - 1) Include rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
 - 2) Dimensions: 5-inch inside width and 9-3/4-inch inside depth. Include number of units required to form total lengths indicated.

- 3) Frame: Galvanized steel or cast iron for grates.
 - b. Grates: Manufacturer's designation "heavy duty," with slots or perforations and of width and thickness that fit recesses in channel sections.
 - 1) Material: Ductile iron or Stainless steel.
 - 2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 - c. Covers: Solid ductile or cast iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 - d. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
 - e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- C. Wide, Level-Invert, Polymer-Concrete, Channel Drainage Systems:
- 1. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 - a. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.
 - 1) Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
 - 2) Dimensions: 8-inch inside width and 13-3/4-inch inside depth. Include number of units required to form total lengths indicated.
 - 3) Frame: Galvanized steel or cast iron for grates.
 - b. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - 1) Material: Ductile iron or Stainless steel.
 - 2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 - c. Covers: Solid ductile or cast iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 - d. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
 - e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 - 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Install expansion joints, if indicated, in roof drain outlets.
 - 3. Position roof drains for easy access and maintenance.
- B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
- C. Install downspout boots at grade with top 12 inches above grade. Secure to building wall.
- D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate cleanouts at base of each vertical storm piping conductor.
- F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- H. Install test tees in vertical conductors and near floor.
- I. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- J. Install horizontal backwater valves in floor with cover flush with floor.
- K. Install drain-outlet backwater valves in outlet of drains.
- L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- M. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

- N. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

- 1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

KSU DESIGNERS NOTES:

- 1. Roof drains shall be no smaller than 3" pipe size.
- 2. Roof drain overflows shall be reviewed with OUA for locations and termination methods.
- 3. Associate shall consider symphonic roof drain type of designs on flat roofs of 1000 square feet and above along with a ½" pond roof design structure. Review design parameters with OUA.

SECTION 221429 - SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Submersible sump pumps.
 - 2. Sump-pump basins and basin covers.

- B. Related Requirements:

- 1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings:

- 1. Include plans, elevations, sections, and mounting attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 PERFORMANCE REQUIREMENTS

- A. Hydraulic Institute Compliance: Design, manufacture and install plumbing pumps in accordance with "Hydraulic Institute Standards."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. UL Compliance: Comply with UL 778 for motor-operated water pumps.
- D. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.

- E. SSPMA Compliance: Test and rate sump and sewage pumps in accordance with the Sump and Sewage Pump Manufacturers Association (SSPMA) Standards.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:

1. Description: Factory-assembled and -tested sump-pump unit.
2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
3. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
4. Impeller: Statically and dynamically balanced, design for clear wastewater handling, and keyed and secured to shaft.
5. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
6. Seal: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: Air or Oil.
8. Sump Pump Manufacturers:
 - a. Hydromatic
 - b. Little Giant (Elevator sump only or approved equal)
 - c. Weil
9. Controls:

Select NEMA Enclosure type below and whether pedestal or wall mount

- a. Enclosure: NEMA 250, Type 1 (indoor) or Type 4X (outdoor); pedestal or wall mounted per plans.
- b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
- c. Automatic Alternator for Duplex Pump Units: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
- d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

10. Control-Interface Features:

- a. Remote Alarm Contacts: For remote alarm interface.
- b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.

11. Capacities and Characteristics – See Drawings for Schedules.

2.2 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
 - 1. Material: Fiberglass or Polyethylene.
 - 2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
 - 3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
 - 1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.
- C. Capacities and Characteristics: See Schedules on Drawings.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.
- B. Sump pumps installed in pits subject to debris and trash accumulation shall be installed in a manner to minimize clogging.

3.4 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Pumps and controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Sump pumps shall be installed in a manner to facilitate easy removal for maintenance.
- C. Sump pumps installed in pits subject to debris and trash accumulation shall be installed in a manner to minimize clogging.

END OF SECTION 221429

KSU DESIGNERS NOTES:

- 1. Provide alarm panel and level alarms communicating through the BAS when required and review construction and features with OUA.**
- 2. Review all sump material types, sizes, and additional manufacturers with OUA.**
- 3. Sump pumps shall be installed in a manner to facilitate easy removal for maintenance. Review type with OUA.**
- 4. Manufacturers not listed must be approved by OUA.**

No master specification section is provided for Water Heaters. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

22 33 00 WATER HEATERS

PART 1 - GENERAL

1.1 CODES AND STANDARDS

- A. Provide water heater components, which are UL listed and labeled.
- B. NSF Compliance: Construct and install water heaters located in food service establishments in accordance with NSF 5, "Standard for Hot Water Generating Equipment for Food Service Establishments using Spray Type Dishwashing Machines."
- C. NEC Compliance: Install electric water heaters in accordance with requirements of NFPA 70, "National Electrical Code."
- D. NFPA Compliance: Install gas fired water heaters in accordance with requirements of NFPA 54, "National Fuel Gas Code."
- E. ASHRAE Compliance: Provide water heaters with Performance Efficiencies not less than prescribed in ASHRAE 90A, "Energy Conservation in New Building Design."
- F. Designs shall incorporate all ASSE, ASTM, and ANSI standards and practices.

1.2 WARRANTY

- A. Warranty on Coil, Heat Exchanger and Burner: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- A. Gas Fired Domestic Water Heaters:
 - 1. AERCO
 - 2. Bradford White
 - 3. Lochinvar Water Heater Corporation
 - 4. PVI
 - 5. RECO
 - 6. RBI
 - 7. Smith Corporation (A.O.); Consumer Products Division
 - 8. State Industries, Inc.

- B. Electric Resistance Domestic Water Heaters:
 - 1. Lochinvar Water Heater Corporation
 - 2. Smith Corporation (A.O.); Consumer Products Division
 - 3. State Industries, Inc.
- C. Steam Fired Domestic Water Heat Exchangers:
 - 1. Taco or approved equal.
 - 2. SARCO
 - 3. AERCO
- D. Semi-Instantaneous Domestic Water Heaters:
 - 1. AERCO
 - 2. Patterson Kelley
 - 3. SARCO

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

4.2 KENT STATE REQUIREMENTS:

- A. Piping to the steam heat exchangers shall be installed in a manner to have clear access for tube repairs and cleaning. Valving shall allow cleaning of one exchanger while the other remains active. Steam traps shall be dual set to allow for maintenance.
- B. Capped threaded connections shall be installed between the exchanger isolation valves and the exchanger for the addition of chemical cleaning solutions thru the exchanger. A drain valve shall be located at the lowest level.
- C. Domestic Hot Water Storage Tanks: Tanks shall be glass lined and include a ten-year warranty on the tank.
- D. Expansion tank to be tagged for system operating pressure and provided with pressure gauge.

KSU DESIGNERS NOTES:

1. All domestic water heating equipment shall be of a high level of energy efficiency. This shall include insulation values, flue dampers, special controls, etc. Details of available options shall be evaluated by the Associate and presented to OUA for discussion. Point of use water heating equipment shall be considered where appropriate to reduce stand by losses and eliminate the need for recirculation systems.
2. Domestic hot water re-circulating systems, where required shall be controlled by the BAS to allow scheduled operation. Provide a BAS temperature sensor in the pipe delivering hot water to the building.
3. Steam heat exchangers used for domestic hot water production shall have straight thru or u-tube design (depending on budget) to facilitate cleaning.
4. Domestic hot water heat exchangers shall be installed in pairs when possible to maintain hot water production during cleaning. This is especially critical in laboratory buildings and residence halls. Each heat exchanger shall be sized to handle at least two thirds of the total peak load, if budget allows provide 100% redundant installations.
5. Piping to the exchangers shall be installed in a manner to have clear access for tube repairs and cleaning. Valving shall allow cleaning of one exchanger while the other remains active. Steam traps shall be dual set to allow for maintenance.
6. A bladder type expansion tank shall be installed on all domestic hot water systems. Expansion tank to be tagged for system operating pressure and provided with pressure gauge. All domestic water heaters on main distribution piping to be designed/engineered with temperature sensor and connected into KSU Building Automation System.
7. Solar thermal domestic hot water active system. Any System shall be considered with evacuated tube, or approved equal using a Glycol type design. The design shall include thermal insulated storage tanks, pumps, back up heating system. The design shall be of a drain down/back design with conventional water heater backup system. The system shall include all of the system main components and shall have a control system, which is Bacnet IP compatible with full read/write control interfaced to the KSU BAS/FMS. All systems shall be designed with an ROI, Energy analysis and will provide on-site training. Factory start-up and commissioning will be included in any design. The design shall be coordinated and approved by OUA. Manufacturers Rheem, AO Smith, and other as approved by OUA.

SECTION 224213 - COMMERCIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Stainless steel sinks.
5. Service basins.
6. Showers.
7. Drinking fountains.
8. Flushometer valves and tanks.
9. Toilet seats.
10. Supports.
11. Faucets.
12. Shower valves.
13. Supply fittings.
14. Waste fittings.

1.3 DEFINITIONS

- A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.
- B. Remote Water Closet: Located more than 30 feet from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves, electronic sensors, faucets, and shower valves to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents. Obtain receipt from Owner.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.
 - 2. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 3. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Standard.
 - 2. Gerber.
 - 3. Kohler Company.
 - 4. Toto.
 - 5. Zurn Company.
- B. Water Closets: Floor mounted, bottom outlet, close-coupled flushometer tank.
 - 1. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASSE/ASME 1037/CSA B125.37.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Pressure assisted.
 - e. Height: Standard or Handicapped/elderly, complying with ICC/ANSI A117.1.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: Maximum 1.6 gal. per flush.
 - h. Color: White.
 - 2. Bowl-to-Drain Connecting Fitting: ASME A112.4.3.
 - 3. Flushometer Tank: Pressure assisted.
 - 4. Toilet Seat: White.

2.2 WALL-MOUNTED WATER CLOSETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Standard.
 2. Gerber.
 3. Kohler Company.
 4. Toto.
 5. Zurn Company.
- B. Water Closets: Wall mounted, top spud, accessible.
1. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.6 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 2. Flushometer Valve: Manual or Automatic
 3. Toilet Seat: White.
 4. Support: Water closet carrier.
 5. Water-Closet Mounting Height: Standard or Handicapped/elderly according to ICC/ANSI A117.1.

2.3 WALL-HUNG URINALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Standard.
 2. Gerber.
 3. Kohler Company.
 4. Toto.
 5. Zurn Company.
- B. Urinals: Wall hung, back outlet, washout, accessible.
1. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Washout with extended shields.
 - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
 - e. Water Consumption: Low.

- f. Spud Size and Location: NPS 3/4, top.
 - g. Outlet Size and Location: NPS 2, back.
 - h. Color: White.
- 2. Flushometer Valve: Manual or Automatic
- 3. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2.
- 4. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights..
- 5. Urinal Mounting Height: Standard or Handicapped/elderly according to ICC A117.1.

2.4 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Standard.
 - 2. Crane Company.
 - 3. Gerber.
 - 4. Kohler Company.
 - 5. Toto.
 - 6. Zurn Company.
- B. Lavatory: Rectangular, self-rimming, vitreous china, counter mounted.
 - 1. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Self-rimming for above-counter mounting.
 - c. Faucet-Hole Punching: Per schedule.
 - d. Faucet-Hole Location: Top.
 - e. Color: White.
 - f. Mounting Material: Sealant.
- C. Lavatory: Oval or Round, self-rimming, vitreous china, counter mounted.
 - 1. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Self-rimming for above-counter mounting.
 - c. Faucet-Hole Punching: Per schedule.
 - d. Faucet-Hole Location: Top.
 - e. Color: White.
 - f. Mounting Material: Sealant.
- D. Lavatory: Oval, vitreous china, undercounter mounted.

1. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For undercounter mounting.
 - c. Faucet-Hole Location: On countertop.
 - d. Color: White.
 - e. Mounting Material: Sealant and undercounter mounting kit.

2.5 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Standard.
 2. Crane Company.
 3. Gerber.
 4. Kohler Company.
 5. Toto.
 6. Zurn Company.
- B. Lavatory: Vitreous china, wall mounted, with back.
 1. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Faucet-Hole Punching: Per schedule.
 - d. Faucet-Hole Location: Top.
 - e. Color: White.
 - f. Mounting Material: Chair carrier.
 2. Support: Type II, concealed-arm lavatory carrier.
 3. Lavatory Mounting Height: Standard or Handicapped/elderly according to ICC A117.1.

2.6 STAINLESS STEEL SINKS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Standard.
 2. Elkay Manufacturing Company.
 3. Just Manufacturing Company.
 4. Tabco.
- B. Stainless steel, counter mounted.
 1. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.

- b. Type: Ledge back.
 - c. Number of Compartments: Per plans.
 - d. Metal Thickness: 18-gauge.
- 2. Faucet(s): Per schedule.
 - a. Mounting: On ledge.
- 3. Supply Fittings:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Loose key.
 - 2) Risers: NPS 1/2, chrome-plated, rigid-copper pipe.
- 4. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap(s):
 - 1) Size: NPS 2.
 - 2) Material: Chrome-plated,; and chrome-plated brass or steel wall flange.
 - 3) Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.
 - c. Continuous Waste:
 - 1) Size: NPS 2.
 - 2) Material: Chrome-plated, 0.032-inch-thick brass tube.
- 5. Mounting: On counter with sealant.

2.7 SERVICE BASINS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Fiat Products or approved equal by KSU OUA.
- C. Service Basins: Terrazzo, floor mounted.
 - 1. Fixture:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Square or Rectangular.
 - c. Nominal Size: 24 by 24 inches or 24 by 36 inches.
 - d. Height: 12 inches.
 - e. Tiling Flange: On two sides.

- f. Rim Guard: On front top surfaces.
 - g. Drain: Grid with NPS 3 outlet.
- 2. Mounting: On floor and flush to wall.
- 3. Faucet: Per schedule.

2.8 SHOWERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aqua Glass Corporation.
 - 2. Clarion Bathware.
 - 3. Kohler.
 - 4. Sterling.
- B. Individual FRP Showers:
 - 1. General: FRP, accessible, shower enclosure with faucet and receptor and appurtenances.
 - 2. Standard: ANSI Z124.1.2.
 - 3. Type: One-piece unit with top.
 - 4. Style: Standard residential or Handicapped/wheelchair per plans.
 - 5. Faucet: Per schedule.
 - 6. Nominal Size and Shape: Per plans.
 - 7. Color: White.
 - 8. Bathing Surface: Slip resistant according to ASTM F 462.
 - 9. Outlet: Drain with NPS 2 outlet.
 - 10. Shower Rod and Curtain: Required.
 - 11. Grab Bar: Per plans.

2.9 DRINKING FOUNTAINS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Elkay EZH2O.
 - 2. Oasis.
- B. Painted cast iron or steel, wheelchair accessible.
 - 1. Cast-Iron or Steel Drinking Fountains:
 - 2. Standards: Comply with ICC A117.1 and NSF 61 Annex G.
 - 3. Receptor(s):
 - a. Number: Two.
 - b. Material: Chrome-plated brass or stainless steel.
 - c. Bubbler: One for each receptor, with adjustable stream regulator.
 - d. Drain: Grid type with NPS 1-1/4 tailpiece.

4. Maximum water flow: 0.15 gpm.
5. Controls: Push bar or Push button.
6. Access to Internal Components: Panel in pedestal.
7. Supply Piping: NPS 3/8 with shutoff valve.
8. Drain Piping: NPS 1-1/4 minimum trap and waste.

C. Drinking Fountains: Stainless steel, wall mounted.

1. Standards:
 - a. Comply with ASME A112.19.3/CSA B45.4.
 - b. Comply with NSF 61 Annex G.
2. Back Panel: Stainless-steel wall plate behind drinking fountain.
3. Bubblers: Two, with adjustable stream regulator, located on deck.
4. Maximum water flow: 0.15 gpm.
5. Control: Push button or Push bar.
6. Drain: Grid type with NPS 1-1/4 tailpiece.
7. Supply: NPS 3/8 with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.
9. Support: Type I water cooler carrier.
10. Drinking Fountain Mounting Height: Standard or Handicapped/elderly according to ICC A117.1.

2.10 WATER CLOSET FLUSHOMETER VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kohler.
2. Moen.
3. Sloan Valve Company (Campus Standard).
4. Toto.
5. Zurn (Subject to OUA review).

B. Lever-Handle, Diaphragm Flushometer Valves:

1. Standard: ASSE 1037.
2. Minimum Pressure Rating: 125 psig.
3. Features: Include integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion-resistant components.
5. Exposed Flushometer-Valve Finish: Chrome plated.
6. Panel Finish: Chrome plated or stainless steel.
7. Style: Exposed.
8. Consumption: 1.6 gal. per flush.
9. Minimum Inlet: NPS 1.
10. Minimum Outlet: NPS 1-1/4.

C. Solenoid-Actuator, Diaphragm Flushometer Valves:

1. Standard: ASSE 1037.
2. Minimum Pressure Rating: 125 psig.
3. Features: Include integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion-resistant components.
5. Exposed Flushometer-Valve Finish: Chrome plated.
6. Panel Finish: Chrome plated or stainless steel.
7. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
9. Trip Mechanism: Battery-powered or Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Consumption: 1.6 gal. per flush.
11. Minimum Inlet: NPS 1.

2.11 URINAL FLUSHOMETER VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kohler.
2. Moen.
3. Sloan Valve Company (Campus Standard).
4. Toto.

- B. Lever-Handle, Diaphragm Flushometer Valves:

1. Standard: ASSE 1037.
2. Minimum Pressure Rating: 125 psig.
3. Features: Include integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion-resistant components.
5. Exposed Flushometer-Valve Finish: Chrome plated.
6. Panel Finish: Chrome plated or stainless steel.
7. Style: Exposed.
8. Consumption: 0.125 gal. per flush.
9. Minimum Inlet: NPS 3/4.

- C. Solenoid-Actuator, Diaphragm Flushometer Valves:

1. Standard: ASSE 1037.
2. Minimum Pressure Rating: 125 psig.
3. Features: Include integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion-resistant components.
5. Exposed Flushometer-Valve Finish: Chrome plated.
6. Panel Finish: Chrome plated or stainless steel.
7. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.

9. Trip Mechanism: Battery-powered or Hard-wired electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Consumption: 0.125 gal. per flush.
11. Minimum Inlet: NPS 3/4.

2.12 TOILET SEATS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Bemis Manufacturing (Campus Standard).
 2. Beneke Corporation.
 3. Church Products.
 4. Olsonite Seats.
- B. Toilet Seats:
 1. Standard: IAPMO/ANSI Z124.5.
 2. Material: Plastic.
 3. Type: Commercial (Standard).
 4. Shape: Elongated rim, open front.
 5. Hinge: Self-sustaining, check.
 6. Hinge Material: Noncorroding metal.
 7. Seat Cover: Required (Tank type water closets); Not required (Flush valve water closets).
 8. Color: White.

2.13 SUPPORTS

- A. Water Closet Carrier:
 1. Standard: ASME A112.6.1M.
 2. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
- B. Urinal Carrier:
 1. Standard: ASME A112.6.1.M.
- C. Type II Lavatory Carrier:
 1. Standard: ASME A112.6.1M.

2.14 SOLID-BRASS, MANUALLY OPERATED LAVATORY/SINK FAUCETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Standard; U.S. Plumbing Products (OUA approval required).
 2. Chicago Faucet Co.
 3. Delta Faucet Co.; Division of Masco Corp.
 4. Moen (OUA approval required).
 5. Toto.
 6. Speakman.
- B. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
- C. Lavatory Faucets: Manual-type,, commercial, solid-brass valve.
1. Standard: ASME A112.18.1/CSA B125.1.
 2. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 3. Body Material: Commercial, solid brass.
 4. Finish: Polished chrome plate.
 5. Maximum Flow Rate: 0.5 gpm.
 6. Mounting Type: Per schedule.
 7. Valve Handle(s): Per schedule.
 8. Spout/Outlet: Per schedule.

2.15 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY/SINK FAUCETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Standard; U.S. Plumbing Products (OUA approval required).
 2. Chicago Faucet Co.
 3. Delta Faucet Co.; Division of Masco Corp.
 4. Moen (OUA approval required).
 5. Toto.
 6. Speakman.
- B. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
- C. Lavatory Faucets: Automatic-type, battery-powered, hard-wired, electronic-sensor-operated, mixing, solid-brass valve.
1. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
 2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 4. Body Material: Commercial, solid brass.
 5. Finish: Polished chrome plate.
 6. Maximum Flow Rate: 0.5 gpm.

7. Mounting Type: Deck, concealed.

2.16 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Standard; U.S. Plumbing Products (OUA approval required).
 2. Chicago Faucet Co.
 3. Delta Faucet Co.; Division of Masco Corp.
 4. Moen (OUA approval required).
 5. Toto.
 6. Speakman.
- B. NSF Standard: Comply with NSF 372 for faucet-spout-outlet materials that will be in contact with potable water.
- C. Description: Chrome-plated-brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.17 SHOWER VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Chicago Faucet.
 2. Grohe.
 3. Kohler.
 4. Moen
 5. Symons.
 6. Toto.
 7. Others as approved by OUA
- B. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.
- C. Shower Faucets:
 1. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
 2. Faucet:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Shower-Arm, Flow-Control Fitting: 1.5 gpm.
 - e. EPA WaterSense: Required.
 - f. Mounting: Concealed.

- g. Operation: Single-handle, twist or rotate control.
 - h. Antiscald Device: Integral with mixing valve.
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
- 3. Supply Connections: NPS 1/2.
 - 4. Shower Head:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: Ball joint with arm and flange.
 - c. Shower Head Material: Metallic with chrome-plated finish.
 - d. Spray Pattern: Adjustable.
 - e. Integral Volume Control: Required.
 - f. Shower-Arm, Flow-Control Fitting: 1.5 gpm.
 - g. Temperature Indicator: Integral with faucet.

D. Shower Faucets:

- 1. Description: Single-handle, thermostatic mixing valve with hot- and cold-water indicators; check stops; and shower head.
- 2. Faucet:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Shower-Arm, Flow-Control Fitting: 1.5 gpm.
 - e. EPA Water-Sense: Required.
 - f. Mounting: Concealed.
 - g. Operation: Single-handle, twist or rotate control.
 - h. Anti-scald Device: Integral with mixing valve.
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
- 3. Supply Connections: NPS 1/2.
- 4. Shower Head:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: Ball joint with arm and flange.
 - c. Shower Head Material: Metallic with chrome-plated finish.
 - d. Spray Pattern: Adjustable.
 - e. Integral Volume Control: Required.
 - f. Shower-Arm, Flow-Control Fitting: 1.5 gpm.
 - g. Temperature Indicator: Integral with faucet.

2.18 SUPPLY FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brasscraft.

2. Chicago Faucets.
 3. McGuire.
 4. Watts.
- B. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
- C. Standard: ASME A112.18.1/CSA B125.1.
- D. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- E. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- F. Operation: Loose key.
- G. Risers:
1. NPS 3/8.
 2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.19 WASTE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brasscraft.
 2. Chicago Faucets.
 3. McGuire.
 4. Watts.
- B. Standard: ASME A112.18.2/CSA B125.2.
- C. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- D. Trap:
1. Size: NPS 1-1/2 by NPS 1-1/4.
 2. Material: Chrome-plated, and chrome-plated, brass or steel wall flange.
 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

2.20 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.

- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine walls and floors for suitable conditions where plumbing fixtures will be installed.
- C. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- D. Examine counters and walls for suitable conditions where lavatories will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.

C. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
5. Install supports, affixed to building substrate, for wall-hung urinals.

6. Use off-floor carriers with waste fitting and seal for back-outlet urinals.

D. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Install flushometer-valve water-supply fitting on each supply to each urinal.
3. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
4. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
5. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
6. Install actuators in locations that are easy for people with disabilities to reach.
7. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

E. Install toilet seats on water closets.

F. Install lavatories level and plumb according to roughing-in drawings.

G. Install supports, affixed to building substrate, for wall-mounted lavatories.

H. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

I. Install sinks level and plumb according to roughing-in drawings.

J. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

K. Set floor-mounted sinks in leveling bed of cement grout.

L. Assemble shower components according to manufacturers' written instructions.

M. Install showers level and plumb according to roughing-in drawings.

N. Install water-supply piping with stop on each supply to each shower faucet.

O. Install shower flow-control fittings with specified maximum flow rates in shower arms.

P. Set shower receptors in leveling bed of cement grout.

Q. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

R. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
4. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
5. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.
6. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- C. Connect lavatories/sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- D. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- E. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- F. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- G. Where installing piping adjacent to water closets, allow space for service and maintenance.
- H. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- C. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- D. Adjust water pressure at flushometer valves to produce proper flow.
- E. Adjust water pressure at faucets to produce proper flow.

- F. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
- G. Adjust fixture flow regulators for proper drinking fountain flow and stream height.

3.5 CLEANING AND PROTECTION

- A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- C. Install protective covering for installed plumbing fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner with receipt in a quantity of one device for each 10 fixtures, not less than 1 device.
- C. Lavatories:
 - 1. All wall hung lavatories to be furnished with carriers.
 - 2. All lavatories shall have integral overflows.
- D. Stainless Steel Sinks:
 - 1. Stainless steel sinks shall be self-centering and fully sound deadened, minimum 304 stainless steel, 16 ga. construction.
- E. Service Basins:
 - 1. Mop basins shall be Fiat molded floor mop sink or equivalent.
 - 2. Sink shall be provided with mop hanger, hose and hose support, stainless steel rim guards and stainless steel splashguards on all adjacent surfaces.
 - 3. Provide faucet with vacuum breaker, pail hook and wall support bracket.
- F. Faucets:

1. Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, O-rings, sleeves and seats in a quantity of 1 kit for each 2 faucets, no less than 1 kit.

G. Toilet Seats:

1. Seats with lifting tabs and anti-loosening hardware to minimize maintenance to be provided.
2. Seats to be have quick lift and locking head device.

H. Supplies and Stops for Lavatories and Sinks:

1. Brass construction with polished chrome finish, lead free, having a loose key quarter turn angle stop having $\frac{1}{2}$ " inlet and $\frac{3}{8}$ " O.D. x 12" long flexible stainless or solid copper with chrome plated tubing supplies to outlet, wall flange and escutcheon.

END OF SECTION 224213

KSU DESIGNERS NOTES:

1. Water Closets and Urinals:

- a. American Standard is the preferred manufacturer.
- b. Water closets and urinals shall be wall mounted whenever possible, with carriers. Fixtures to 1.6 gal. for WC and 1/2 to 1/8 gal. for UR.
- c. Residence hall water closets can be tank type pressure assist with locking, cover, top push button flush actuator and dual flush volume capability.
- d. Water closets and urinals shall be "wash-out" style with water saver features, coordinate with OUA.

2. Stainless Steel Sinks: Just Manufacturing Company is the preferred manufacturer.

3. Mop Basins: Sink shall be 24"X36"X10" high preferred where possible.

4. Faucets:

- a. Chicago Faucets is the preferred manufacturer.
- b. Public Lavatories faucets shall be meter of infrared type for all public restrooms. Review with OUA.
- c. Specify 0.5 GPM aerators or Moen 0.35 GPM. OUA approval required for higher flow aerators.
- d. Associated tempering/mixing valve locations to be coordinated with OUA.

5. Flush Valves:

- a. Sloan is the campus standard. **EDIT ABOVE IF TO BE SOLE SPECIFIED ON PROJECT AFTER REVIEWING WITH OUA.**

- b. Battery or Hard wired infrared hands free operated for all ADA fixtures and at public urinals. Installation type to be reviewed by OUA.
- 6. Showers and Shower Valves:
 - a. One-piece acrylic fiberglass units complete with dome light, fully hinged tempered glass shower door with full length magnetic latching. Showers shall be set level and concrete bedded for uniform support. ADA units shall be supplied with Stainless Steel Supports, ADA folding or permanent seat, Temperature and pressure shower valves with hand held shower with stainless steel slide bar, low flow shower head. Provide unit with stainless steel curtain rod and anti-microbial shower curtain.
 - b. Shower shall be furnished with temperature and pressure balanced mixing valves with integral stops. Review internal components with OUA.
 - c. Review all ADA showers with OUA.
- 7. Toilet Seats: Bemis Manufacturing is the Campus Standard.
- 8. Water Coolers:
 - a. Elkay EZH2O with bottle filling station is campus standard.
 - b. University standard drinking fountain is the Oasis or Elkay, automatic run handicap accessible water cooler with wall mounting frame. Other drinking fountain styles are acceptable, but shall be submitted to OUA for review prior to incorporation into the project.
 - c. Provide a minimum of one (1) bottle filling station at the expected high traffic water cooler location to advance sustainability efforts and reduce single use bottled water on campus. Elkay EZH2O preferred.
- 9. Stops and Supplies for Lavatories and Sinks: McGuire is preferred manufacturer.

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Eye/face wash equipment.
- 2. Combination units.
- 3. Water-tempering equipment.

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

Retain below only if electric is used for tempering equipment

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 EYE/FACE WASH EQUIPMENT

- A. Manufacturers subject to compliance with requirements, provide products by one of the following:
 - 1. Eyewash Equipment.
 - Acorn Engineering Company
 - Bradley Corporation
 - Encon Safety Product
 - Guardian Equipment Co.
 - Haws Corporation;
 - Speakman Co.
- B. Standard, Freestanding, Plumbed, Eye/Face Wash Units:
 - 1. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - 2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - 3. Control-Valve Actuator: Paddle.
 - 4. Spray-Head Assembly: Two receptor-mounted spray heads.
 - 5. Receptor: Plastic bowl.
 - 6. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include galvanized-steel indirect connection to drainage system.
 - 7. Mounting: Pedestal.
- C. Accessible (Barrier Free), Freestanding, Plumbed, Eye/Face Wash Units:
 - 1. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - 2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.

3. Control-Valve Actuator: Paddle.
4. Spray-Head Assembly: Two receptor-mounted spray heads.
5. Receptor: Plastic bowl.
6. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include galvanized-steel indirect connection to drainage system.
7. Mounting: Offset pedestal.
8. Special Construction: Comply with ICC/ANSI A117.1.

D. Standard, Wall-Mounted, Plumbed, Eye/Face Wash Units:

1. Capacity: Not less than 3.0 gpm for at least 15 minutes.
2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
3. Control-Valve Actuator: Paddle.
4. Spray-Head Assembly: Two receptor-mounted spray heads.
5. Receptor: Plastic bowl.
6. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
7. Mounting: Wall bracket.

E. Accessible (Barrier Free), Wall-Mounted, Plumbed, Eye/Face Wash Units:

1. Capacity: Not less than 3.0 gpm for at least 15 minutes.
2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
3. Control-Valve Actuator: Paddle.
4. Spray-Head Assembly: Two or four receptor-mounted spray heads.
5. Receptor: Plastic bowl.
6. Mounting: Wall bracket.
7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
8. Special Construction: Comply with ICC/ANSI A117.1.

F. Sink, Fixed-Position, Plumbed, Eye/Face Wash Unit:

1. Capacity: Not less than 3.0 gpm for at least 15 minutes.
2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
3. Control-Valve Actuator: Paddle.
4. Spray-Head Assembly: Two spray heads positioned over sink.
5. Mounting: Attached to sink receptor.

2.2 COMBINATION UNITS

A. Manufacturers subject to compliance with requirements, provide products by one of the following:

1. Combination Units:
Acorn Engineering Company

Bradley Corporation
Encon Safety Products
Guardian Equipment Co.
Haws Corporation
Speakman Co.

B. Standard, Plumbed Emergency Shower with Eye/Face Wash Combination Units:

1. Piping:

- a. Material: Chrome-plated brass.
- b. Unit Supply: NPS 1-1/4 minimum.
- c. Unit Drain: Outlet at back or side near bottom.

2. Shower:

- a. Capacity: Not less than 20 gpm for at least 15 minutes.
- b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
- c. Control-Valve Actuator: Pull rod.
- d. Shower Head: 8-inch- minimum diameter, plastic.
- e. Mounting: Pedestal.

3. Eye/Face Wash Unit:

- a. Capacity: Not less than 3.0 gpm for at least 15 minutes.
- b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
- c. Control-Valve Actuator: Paddle.
- d. Spray-Head Assembly: Two receptor-mounted spray heads.
- e. Receptor: Plastic bowl.
- f. Mounting: Attached shower pedestal.
- g. Drench-Hose Option: May be provided instead of eye/face wash unit.
 - 1) Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - 2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
 - 3) Mounting: Bracket on shower pedestal.

C. Accessible (Barrier Free), Plumbed Emergency Shower with Eye/Face Wash Combination Units:

1. Piping:

- a. Material: Chrome-plated.
- b. Unit Supply: NPS 1-1/4 minimum.
- c. Unit Drain: Outlet at back or side near bottom.

2. Shower:

- a. Capacity: Not less than 20 gpm for at least 15 minutes.
- b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
- c. Control-Valve Actuator: Pull rod.
- d. Shower Head: 8-inch- minimum diameter, plastic.

- e. Mounting: Pedestal.
- 3. Eye/Face Wash Unit:
 - a. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Plastic bowl.
 - f. Mounting: Attached to shower pedestal.
 - g. Drench-Hose Option: May be provided instead of eye/face wash unit.
 - 1) Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - 2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
 - 3) Mounting: Bracket on shower pedestal.
- D. Recessed, Plumbed Emergency Shower with Eye/Face Wash Combination Units:
 - 1. Piping:
 - a. Material: Copper for concealed piping, Stainless steel for exposed piping.
 - b. Unit Supply: NPS 1-1/4 minimum.
 - c. Unit Drain: Outlet at back.
 - 2. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Heavy duty stainless steel panic bar.
 - d. Shower Head: 8-inch- minimum diameter, stainless steel 8" diameter.
 - e. Mounting: Recessed or Exposed.
 - 3. Eye/Face Wash Unit:
 - a. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Fold down cover pan.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Stainless steel.
 - f. Mounting: Recessed in wall with Stainless steel enclosure.

2.3 WATER-TEMPERING EQUIPMENT

- A. Manufacturers subject to compliance with requirements, provide products by one of the following:
 - 1. Water-Tempering Equipment:
 - Acorn Engineering Company
 - Armstrong-Lynwood, Inc.
 - Bradley Corporation

Encon Safety Products
Guardian Equipment Co.
Haws Corporation
Lawler Manufacturing Co., Inc.
Leonard Valve Co.
Powers, Inc.
Speakman Co.

B. Hot- and Cold-Water, Water-Tempering Equipment:

1. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. Thermostatic Mixing Valve: Designed to provide 85 deg F (or as dictated by safety personnel) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
 - b. Supply Connections: For hot and cold water.
2. Description: Factory-fabricated equipment with electric heating.
 - a. Heating System: Electric, designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, heating coils, high-temperature-limit device, metal piping, and corrosion-resistant enclosure.
 - 1) Electrical Characteristics: See Schedules on Drawings.

2.4 SOURCE QUALITY CONTROL

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.

- C. Fasten fixtures to substrate.
- D. Install ball shutoff valves in water-supply piping to fixtures. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

Retain first paragraph below for units with direct connection to sanitary system or second paragraph for indirect connection.

- G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 CONNECTIONS

- A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

Retain first paragraph below for units with direct connection to sanitary system or second paragraph for indirect connection.

- B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- C. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.
- D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

END OF SECTION 224500

KSU DESIGNERS NOTES:

1. Lawler Manufacturing Co., Inc. is the preferred manufacturer for KSU projects.
2. Each research or general laboratory shall be furnished with an emergency eyewash station or combination eyewash/shower.
3. Sanitary drainage system shall be coordinated with the science department and the use of chemical resistant system type shall be review with OUA.
4. Tepid domestic water system shall be utilized for any safety equipment. The review of temperature setting shall be reviewed with KSU safety personnel and end user of the laboratory. Written operating, testing and maintenance program of emergency lab safety devices of system shall be required to be submitted on any system being installed.
5. Training on proper use shall also be incorporated into the design for lab spaces.
6. All tepid water system shall use master mixing valve designed for use in this type of application with "Lawler" is the preferred manufacturer of mixing valves.
7. Coordinate termination of drain piping with OUA. Acid neutralization may be required in certain situations.

KSU SPECIFICATIONS

DIVISION 23

230500	Common Work Results for HVAC
230501	Basic Mechanical Materials and Methods for HVAC
230513	Common Motor Requirements for HVAC Equipment
230516	Expansion Fittings and Loops for HVAC Piping
230517	Sleeves and Sleeve Seals for HVAC Piping
230518	Escutcheons for HVAC Piping
230519	Meters and Gages for HVAC Piping
230523	General Duty Valves and Strainers
230529	Hangers and Supports for HVAC Piping and Equipment
230548	Vibration Controls for HVAC
230553	Identification for HVAC Piping and Equipment
230593	Testing, Adjusting and Balancing for HVAC
230713	Duct Insulation
230716	HVAC Equipment Insulation
230719	HVAC Piping Insulation
232113	Hydronic Piping
232116	Hydronic Piping Specialties
232123	Hydronic Pumps
232213	Steam and Condensate Heating Piping
232216	Steam and Condensate Piping Specialties
232223	Steam Condensate Pumps
232300	Refrigerant Piping
232500	Chemical Treatment
233113	Metal Ducts
233300	Air Duct Accessories
233413	Axial HVAC Fans
233416	Centrifugal HVAC Fans
233423	HVAC Power Ventilators
235100	Breechings, Chimneys and Stacks
235200	Heating Boilers
235700	Heat Exchangers for HVAC
236200	Packaged Compressor and Condenser Units
236313	Air Cooled Condensers
236433	Packaged Water Chillers
236500	Cooling Towers
237000	Central HVAC Equipment
237100	Variable Speed Drives (VDS)
238000	Decentralized HVAC Equipment
238123	Computer Room Air Conditioners
238124	Tele-Data Room Air Conditioners
238124	VRF Heating and Cooling Systems
238239.13	Cabinet Unit Heaters
238239.16	Propeller Unit Heaters
238239.19	Wall and Ceiling Unit Heaters
250000	Temperature Controls
259000	Integrated Automation Control Sequences

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 GENERAL REFERENCE

Retain or edit sections below as they pertain to the project.

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to work of this section.
- B. Refer to Division 01 section "Alternates" for possible alternates affecting the extent of this Section of work.

Retain below only if it is applicable to the project. Coordinate Specification number below.

- C. Specification Section 018113.13 Sustainable Design Requirements apply to work specified in this section.
- D. Specification Section 018113c Indoor Air Quality Management Plan during construction apply to work specified in this section.
- E. This Contractor is also referred to the Plumbing, Architectural, Structural, Electrical and all other drawings and specifications pertinent to this project. All of the above mentioned drawings and specifications are considered a part of the Contract Documents.
- F. This section specifies the basic requirements for HVAC installations and includes requirements common to more than one section of Division 23. It expands and supplements the requirements specified in sections of Division 01.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

Select one of the two paragraphs after coordinating with the Architect. Paragraph "A" is for one prime contractor, "B" is for multiple contractors.

- H. The term "Contractor" as applied to work specified, shown or reasonably implied in the contract documents for Division 23 shall be defined as the subcontractor who is responsible for the work specified or indicated. All subcontracted work must be incorporated by and coordinated by the prime contractor.
- I. The term "Contractor" as applied to work specified, shown or reasonably implied in the contract documents for Division 23 shall be defined as the each prime contractor who is responsible for the work specified, or indicated. All work subcontracted to each prime contractor must be incorporated by and coordinated by each prime contractor.

Use Paragraph "C" below if the Engineer is the lead design professional, "D" if the Architect is the lead. Fill in blank with Engineering firm.

- J. Throughout this specification section the term "Design Professional" is referenced. The specification calls for certain actions to be undertaken or referred to the Design Professional. Accordingly, the term "Design Professional" shall be defined as the firm with which the "Owner" has contracted to produce the contract drawings and specifications. It shall be understood that the Design Professional for this project is .
- K. Throughout this specification section the term "Design Professional" is referenced. The specification calls for certain actions to be undertaken or referred to the Design Professional. Accordingly, the term "Design Professional" shall be defined as the firm with which the "Owner" has contracted to produce the contract drawings and specifications. It shall be understood that the Design Professional for this project is the Architect whose name is shown on the drawing title block.

1.3 QUALITY ASSURANCE

- A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at the expense of the HVAC contractor. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.4 HVAC COORDINATION

- A. This Contractor shall familiarize himself with the work to be done under other Divisions of this specification and their related drawings and shall so coordinate and schedule his work as not to cause delays or interference with the work of others. Such coordination and scheduling shall

accomplish the installation of equipment and piping with a minimum of cutting through masonry and other adjustments.

- B. Ceiling grid systems shall not be supported from ductwork, HVAC piping or any other utility lines, and vice versa. Each utility and the ceiling grid system shall be a separate installation and each shall be independently supported from the building structure-concrete, steel or masonry. Where interferences occur, in order to support ductwork, piping, ceiling grid systems, etc., trapeze type hangers or supports shall be employed which shall be located so as not to interfere with access to such mechanical equipment as valves, regulators, VAV or reheat terminals, fire dampers, etc.

The following requirement for each contractor to be responsible for their own openings is preferred. Coordinate with Architect and Section 230501.

- C. This Contractor shall be responsible for proper size and location of anchors, chases, recesses, openings, etc., required for the proper installation of his work. Verify all dimensions by field measurements. Coordinate the installation of required supporting devices and sleeves in structural components as they are constructed. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work.
- D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors.

Retain reference below to Division 08 if applicable, otherwise provide specification for Access Doors.

- F. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- G. Allow ample space for removal of all parts that require replacement or servicing. Extend all grease fittings to an accessible location. Install equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with a minimum of interference with other installations. Sequence, coordinate, and integrate installations of HVAC materials and equipment for efficient flow of the work.
- H. All mechanical equipment, especially piping, shall be at least three feet away horizontally from any electrical switchgear or transformers. No hydronic lines or steam lines shall pass through telephone, transformer, switchgear rooms or elevator equipment rooms.
- I. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

Coordinate the following items with the Architect and edit accordingly.

- A. Specific divisions of responsibility when coordinating with trades other than mechanical shall be as indicated on drawings, in Division 01, and as follows. The Contractors under this Division shall:

1. Run the indicated utilities outside the building to points as noted on the drawings. He shall be responsible for the actual tie-in to street utility services where routing to site utility services on drawings pertaining to this Division are indicated.
2. Provide and place all sleeves in floors, walls, etc., and coordinate such location.
3. Be responsible for flashing at roof vent terminals.
4. Rough-in and connect all equipment furnished by other trades or Owner where shown on the drawings.
5. Provide motors, special controls, transformers and relays as required for the proper operation of all equipment furnished by him under this Division.
6. Coordinate the location of floor drains and cleanouts with architectural and structural elements or work of other trades affecting the location of floor drains and cleanouts. Where floor drains are installed to serve specific pieces of equipment, coordinate the location of floor drains with the contractor who is providing the equipment, using manufacturer's shop drawings for the equipment served or written instructions from the equipment manufacturer.

1.5 EXAMINATION OF SITE

- A. Before submitting a bid, the Contractor is requested to visit the job site to familiarize himself with construction conditions. No consideration or remuneration will be given for his failure to do so.

1.6 DIVISION 23 DESIGN DOCUMENTS

Select one of the following two paragraphs. "A" is for projects with one Prime Contractor. "B" is for projects with multiple Prime Contractors.

- A. Should it appear that there is a discrepancy between or within the drawings and/or specifications concerning the nature, quality or extent of materials or work to be furnished and/or installed, and such discrepancy is not clarified by Addendum during the bidding period, this Contractor shall base his bid on performing the work in the manner having the higher cost. The Design Professional shall have the option of selecting either of the manners shown and/or specified. In the event the lower cost manner is selected, a credit shall be due the Owner in the amount of the difference between the lower cost and higher cost manner. Any discrepancies shall be called to the attention of the Design Professional before proceeding with work affected thereby.
- B. Should it appear that there is a duplication on the Drawings or in the Specifications, wherein the same work or items are shown or specified as being provided under different contracts, subcontracts or supply orders, and such duplication is not clarified by Addendum during the bidding period, it shall be assumed that the prime contractors have included duplicate quotations in their proposal to the Owner. The Design Professional shall have the option of selecting the contract, subcontract or supply order under which the work or items are to be provided and a credit shall be due the Owner for the duplicate work or items.
- C. Where a discrepancy exists within the specifications, among the drawings, or between the specifications and the drawings, refer to project supplementary conditions.
- D. Should it appear that there is a duplication on the drawings or in the specifications, wherein the same work or items are shown or specified as being provided under separate subcontracts or

supply orders, and such duplication is not clarified by addendum during the bidding period, it shall be assumed that the responsible prime contractor will select and coordinate which subcontract will supply the item and the item will be supplied as indicated. Occasionally, certain references may be indicated on the Drawings to items which are suggested to be furnished and/or installed by various subcontractors. This is done to assist the applicable Prime Contractor in organizing his subcontractor's bids. However, no attempt has been made, nor is it implied, that this specification or plans are attempting to specifically divide all responsibilities for subcontractors. It is the Prime Contractor's responsibility that all items covered on HVAC plans and Division 23 specifications are included in his bid and are coordinated with his subcontractors. No consideration will be given for Prime Contractor's failure to include all applicable mechanical work in his bid.

- E. The design drawings, as submitted, are diagrammatic and are not intended to show exact location of equipment, piping and ductwork unless dimensions are given. Drawings are not to be scaled.
 - 1. Equipment shall be installed along the general arrangement indicated on the drawings, and in accordance with the manufacturer's instructions.
 - a. Provide at least the minimum manufacturer's recommended and code required clearance around the equipment for normal maintenance.
 - b. Locate and arrange equipment in relationship to other system components to assure that the equipment will be operating under the best possible conditions to meet the scheduled performance requirements.
 - 2. Piping and ductwork are to be installed along the general plans shown on the drawings keeping in mind the constraints of the available space and the need to coordinate with the work of other trades. Additional offset and fittings shall be provided as necessary to meet space constraints and to facilitate the work of other trades.
 - a. Recognizing the potential need for additional offsets and fittings in piping and ductwork, the Engineer has included a safety factor in all friction calculations. The Contractor is advised to plan and coordinate his work carefully to minimize the need for additional offsets and fittings. The Contractor shall be responsible to notify the Engineer of any and all modifications to systems which may affect the ability of equipment to serve its intended use prior to the purchase and installation of such equipment.
- F. All equipment, piping and material specified hereinafter as shown on the drawings shall be furnished and installed by this Contractor, unless specifically indicated to the contrary.
- G. If this Contractor proposes to install equipment requiring space conditions other than those as specified and/or shown on the design drawings, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall obtain the full approval of the Design Professional before proceeding with the work.

1.7 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements of this division, and in Division 01.
- B. This Contractor shall record all changes from original design drawings which were made during the installation of the work. These changes shall be recorded in red ink on a designated set of prints. Changes shall be accurately dimensioned and/or drawn to scale.
- C. This Contractor shall keep an updated set of specifications and prints, including changes on the job site, at all times and shall submit one (1) set of updated and legible prints to the Design Professional when the work is complete.

1.8 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades under this Division shall submit coordination drawings in AutoCAD, drawn to scale ($\frac{1}{4}"=1'-0"$ or larger) for review. Refer to project schedule for required submission dates. Such drawings will be required throughout all areas for all trades. Prepare Coordination Drawings as Follows:
 - 1. The HVAC Contractor shall prepare the base plan coordination drawings showing all ductwork, all pertinent heating piping and equipment. The drawings shall be coordinated with lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearances, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Architect and Engineer. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of contract. Minor revisions need not be redrawn.
 - 2. HVAC Contractor shall provide the base plan in AutoCad and submit the base plan to all major trades' Contractors. All ductwork and piping shall be on separate layers.
 - 3. The Fire Protection Contractor shall draft location of piping, sprinkler heads and equipment on the base plan using a separate layer, indicating areas of conflict and suggested resolutions.
 - 4. The Plumbing Contractor shall draft location of all piping and equipment on the base plan using a separate layer.
 - 5. The Electrical Contractor shall draft location of lighting fixtures, cable trays, and feeders over 2 in. on the base plan using a separate layer, indicating areas of conflict and suggested resolution.
 - 6. The HVAC Contractor shall then combine all layers on a composite AutoCad drawing indicating all areas of conflict.
 - 7. The General Trades Contractor shall indicate areas of architectural/structural conflicts or obstacles and coordinate to suit the overall construction schedule.
 - 8. The Construction Manager shall expedite all drawing work and coordinate to suit the overall construction schedule. He shall then review these drawings and compare them with the architectural, structural, equipment and other drawings and determine that all of the work can be installed without interference. In the case of unresolved interferences, he shall notify the Architect. The Architect will then direct the various Contractors as to how to revise their drawings as required to eliminate installation interferences.
 - 9. If a given trade proceeds prior to resolving conflicts, then, if necessary, that trade shall change its work at no extra cost in order to permit others to proceed with a coordinated

installation. Coordination approval will be given for individual areas after special site meetings involving all Trades.

10. Coordination drawings are intended for the respective Contractor's use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these contract documents.
11. After resolution of all conflicts, all trades shall sign and date a hard copy of the composite coordination drawing.

1.9 SHOP DRAWINGS

- A. Refer to the conditions of the Contract (General and Supplementary) and Division 01 Section: Shop drawings, product data, and samples for submittal definitions, requirements, and procedures. Refer to project schedule for required submission dates.

Retain above if there is a Division 01 specification with the project. If not, include the paragraph below.

- B. Submit electronic copy of shop drawings to the Design Professional.
- C. This Contractor shall review, stamp and sign with his approval and submit, with reasonable promptness and in orderly sequence so as to cause no delay in the work or in the work of any other Contractor, all submittal information required by the contract documents. Shop drawings not stamped with Contractor approval will be returned for reprocessing.
 1. Shop drawings shall only cover equipment or components that are being provided. Failure to edit shop drawings and options will be reason for rejection.
 2. In approving the submittals, the Contractor guarantees that the submittals accurately and completely represent the equipment and materials to be installed.
 3. Shop drawings shall be submitted for ALL material items as outlined in these specifications. Any deviations from contract requirements must be clearly indicated on shop drawings, and justification for their consideration must be included.
 4. Acceptance of submittal items will not preclude rejection of those items upon later discovery that their suitability for the application or ability to meet the requirements of these specifications was misrepresented in the submittals.
 5. Equipment shop drawings shall include nameplate data, model number and efficiency rating along with full load amps for all electrical motors.
 6. Submittals for equipment shall include detailed dimensional drawings which completely and accurately represent the specific piece of equipment to be supplied. When more than one piece of similar equipment is to be supplied, provide accurate dimensional drawings for each unique size and/or configuration of the equipment.
- D. In checking shop drawings, the Design Professional will make every effort to detect and correct errors, omissions and inaccuracies in such drawings, but his failure to detect errors, omissions and inaccuracies shall not relieve the Contractor of responsibility for the proper and complete installation in accordance with the intent of the Contract Documents.

1.10 EQUIPMENT

- A. Before entering into a contract, the successful bidder may be required to submit satisfactory evidence to show that the manufacturer of all parts of the equipment offered have been regularly engaged in the manufacture of such equipment for three (3) years and have not less than three (3) installations of a similar type which have been in successful operation under conditions similar to those specified for not less than two (2) years.
- B. When two or more items of same equipment are required (pumps, valves, etc.) they shall be of the same manufacturer.
- C. In placing his bid, the Contractors under this Division shall take note that manufacturer's products change frequently, and only the scheduled products have been checked by the Engineer for compliance with the Contract Documents and physical characteristics. Other manufacturers are listed because they are believed to be capable of complying, and in order to achieve fair and competitive bidding. However, it is the responsibility of the manufacturer in his relationship with the Contractor to bid to the Contractor only products complying with the Contract Documents, and the responsibility of the Contractor to base his bid only on manufacturers which do comply. No consideration will be given to the Contractor for his failure to do this. Should Contractors during the bidding process discover that listed manufacturers cannot comply with the Documents, they are encouraged to contact the Engineer as soon as practical, and provided sufficient time in the bidding process exists, and the Engineer agrees with the request, the Engineer will attempt to adjust the documents in the addendum process. If no addendum is issued adjusting the requirements so that all listed manufacturers can bid, the Contractor will be required to supply one of the listed manufacturers which comply with the Contract Document requirements.

1.11 SUBSTITUTIONS

- A. Refer to the Instructions to Bidders and the related Division 01 sections for requirements in selecting products and requesting substitutions.

Make sure Division 01 addresses substitutions, if not include paragraphs B&C below. If covered in Division 01, delete paragraphs B&C.

- B. Bids concerning the use of substitute products must be accompanied by complete specifications and performance characteristics covering these products, together with such available test data and experience records as may be helpful to the Design Professional in evaluating the quality and/or suitability of the proposed products.
- C. The intent of this paragraph is to make the specifications open to all available makes of material and apparatus during the bidding period. Certain definite makes or kinds of items are specified as "standards of quality" and character required. Each Contractor is required to bid upon the basis of furnishing the makes specified. He is also invited to bid on any other similar makes he (the Contractor) may desire to propose as substitutions, stating any difference in cost for each proposed substitution on the Substitution Sheet, if there is a difference. If the Design Professional shall decide to accept any of the proposed substitutions, proper notations thereof shall be made in the written contract. Where several makes are mentioned in the specifications and the Contractor fails to state that he prefers a particular make in his bid, the Owner shall have the right to choose any of the makes mentioned without change in price. No consideration will be given to proposals for alternative products unless submitted with the original bids.

1.12 SUPERVISION

Coordinate whether a full time superintendent is required for the project. Typically required when this contractor is the Prime Contractor.

- A. The HVAC Contractor shall have in charge of work at all times during construction, a competent foreman or superintendent whose experience and background shall qualify him for the work to be performed under this division. Once assigned, the foreman or superintendent shall be retained until completion of the project and any consideration as to his removal on grounds of incompetence shall either be initiated by or referred to the Design Professional for decision. Contractor is to provide a resume for the superintendent/foreman with prior approval by the owner.

1.13 CODES AND PERMITS

- A. All equipment, materials, and installation shall comply with the National Fire Protection Association's "National Fire Codes" and "National Electrical Code". Equipment shall bear the "UL" label as required by these codes.
- B. Install work in full accordance with rules and regulations of State, County and City authorities having jurisdiction over premises. This shall include safety requirements of Ohio State Department of Industrial Relations. Do not construe this as relieving Contractor from compliance with any requirements of specifications which are in excess of Code requirements and not in conflict therewith.
- C. Unless otherwise indicated, secure and pay for all permits and certificates of inspection incidental to this work required by foregoing authorities. Be responsible for payments to all public utilities for work performed by them in connection with provision of service connections required under this DIVISION of specifications. Deliver all certificates to Design Professional in duplicate.
- D. The contractor shall be required to comply with OSHA requirement for physical hazards, safety equipment, fire fighting equipment and protective equipment.
- E. Belt guards, coupling guards, rails, roof fall protection, etc. shall be provided to meet OSHA requirements. Vent shafts and vertical openings shall be enclosed and comply with all OSHA requirements.

1.14 INTERFERENCES

- A. Before installing any work, this Contractor shall see that it does not interfere with clearance required for finish on beams, columns, pilasters, walls or other structural or architectural members, as shown on Architectural Drawings. If any work is so installed and it later develops that Architectural design cannot be followed, Contractor shall, at his own expense, make such changes in his work as the Design Professional may direct to permit completion of Architectural work in accordance with plans and specifications.
- B. Install additional offsets on piping or ductwork where required to obtain maximum headroom or to avoid conflict with other work without additional cost to the Owner. Where mounting heights

are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

- C. Report any interferences between work under this division and that of any other Contractors to the Design Professional as soon as they are discovered. The Design Professional will determine which equipment shall be relocated, regardless of which was first installed, and his decision shall be final.

1.15 SHOP AREAS AND MATERIAL STORAGE

- A. No mechanical related trade is permitted to use as shop working area, any concrete slab that is to receive metallic waterproofing, asphalt tile, plastic tile, etc., except by express permission of the Design Professional.
- B. The Contractor shall make provisions for the delivery and safe storage of his materials and equipment in coordination with the work of others. Materials and equipment shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected. The arrival and placing of large equipment items shall be scheduled early enough to permit entry and setting when there is no restriction or problem due to size and weight. Stored piping, ductwork, and equipment to be covered and sealed at all open ends.

1.16 CLEAN-UP

- A. Refer to the Division 01 for general requirements for project cleaning. Contractor is responsible for cleaning each day.
- B. Insofar as the HVAC work is concerned, at all times keep premises and building in neat and orderly condition, follow explicitly any instructions of Design Professional in regard to storing of materials, protective measures, cleaning-up of debris, etc.
- C. Upon completion of work, this Contractor shall thoroughly clean all apparatus furnished by him, pack all valves and thoroughly clean piping, ductwork and equipment removing all dirt, grease and oil.
- D. Air systems shall not be operated without filters. Upon completion of work replace all filters.
- E. All equipment to be thoroughly cleaned prior to startup.

1.17 OPERATING AND MAINTENANCE

- A. This Contractor shall furnish competent personal instruction to the Owner's operating personnel for a period of hours as indicated in individual Division 23 specification sections in the proper operation of the mechanical equipment. He shall also supply the Owner with three (1) hardbound copies of an operation manual bound in a transparent vinyl sleeve on the front of the binder and binder edge to protect labeling and (1) electronic copy in "PDF" format on disk. The manual shall be labeled on the front as well as the binder with the project name, project number, and the

trade covered (i.e. “HVAC”, etc.). The operating and maintenance manual shall include the following:

1. Cover sheet with project name, number, and contractor.
2. Contractor and sub-contractor contact and phone list.
3. Contractor warranty, indicating date of final acceptance and expiration.
4. Equipment and material warranties and guarantees.
5. Contact names and phone numbers for each product.
6. Table of contents.
7. Tabbed sections for each topic included in the manual.
8. Complete equipment list with model and serial number.
9. Manuals shall indicate all local suppliers of equipment.
10. Step-by-step procedures for start-up and shutdown for each system and piece of equipment.
11. Performance data, curves, ratings.
12. Wiring diagrams.
13. Manufacturer's descriptive literature.
14. Automatic controls with diagrams and written sequence of operation.
15. Manufacturer's maintenance and service manuals.
16. Spare parts and replacement parts list for each piece of equipment.
17. Name of service agency and installer complete with an emergency service phone number for nights, weekends and holidays.
18. Final approved shop drawings indicating actual device/equipment provided, not generic product data.
19. Final approved balance reports.
20. Final Operating parameters (CFM, pressures, GPM etc.) Parameters must match TAB and Commissioning reports.

1.18 WARRANTIES

- A. Refer to the Division 01 Section: Specific Warranties for procedures and submittal requirements for warranties. Refer to individual equipment specifications for additional warranty requirements.
- B. Furnish to owner two (2) hard copies and (1) electronic in “PDF” format along with contact names, phone numbers, and email address for each product.
- C. This Contractor shall warranty all materials, workmanship and the successful operation of all equipment and apparatus installed by him for a period of one year from the date of the final acceptance of the entire work and shall guarantee to repair or replace at his own expense any part of the apparatus which may show defect during that time provided such defect is, in the opinion of the Design Professional, due to imperfect material or workmanship and not to carelessness or improper use. Compile and assemble the warranties specified in Division 23 into a separated set of vinyl covered three-ring binders, tabulated and indexed for easy reference.

1.19 TEMPORARY SERVICES

Elaborate on temporary services in Division 01, not this section. Make sure to cover utility charges in Division 01. Review the use of permanent equipment with Owner.

- A. The Contractor under this division shall provide temporary services, i.e.: heat, cooling, ventilation, or water, fuel, sanitary, or storm as specified herein or in Division 01 "General Conditions" and "Special Conditions" portions of this specification.
- B. Permanent equipment may be used for temporary (construction period) services only as directed by the Design Professional. Any permanent equipment used, shall be maintained by this Contractor. Owner's warrantee period shall not begin until final acceptance of the completed system.
- C. Permanent air handling units may be used during the construction period for heating or "drying-out" the building, however, unit shall operate in 100% outside air mode, with filters installed at all return air grilles and registers in the building. Air handling filters shall be provided by the contractor and shall not count toward the initial or spare filter sets provided at project completion. Prior to utilizing air handling units in such a manner, the air handling unit manufacturer shall perform startup inspections to prevent damage to the equipment.

1.20 PROTECTION OF WORK AND PROPERTY

- A. The Contractor shall be responsible for safeguarding work, property and facilities against damage, both his own as well as others, with which he may come into contact in the performance of his work.
- B. Stored materials shall be protected against damage from weather. Pipe and duct openings shall be closed with caps or plugs during installation. All fixtures and equipment shall be covered and protected against injury. Any materials or equipment damaged at any stage in the construction shall be replaced or repaired, and at the final completion of all work shall be in a clean, unblemished condition.

1.21 CUTTING AND PATCHING

Retain paragraph below only if Division 01 is included in the project.

- A. Refer to the Division 01 Section: CUTTING AND PATCHING for general requirements for cutting and patching.
- B. Do not endanger or damage installed Work through procedures and processes of cutting and patching. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

If Division 01 is used, coordinate if Division 23 Contractors are to do their own cutting and patching with Architect. Usually, Division 23 cut and patch should be by the Division 23 Contractors.

- C. The contractor under this division shall perform cutting, fitting, and patching of building components and mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work;
2. Remove and replace defective Work;
3. Remove and replace Work not conforming to requirements of the Contract Documents;
4. Remove samples of installed Work as specified for testing;
5. Install equipment and materials in existing structures;
6. Upon written instructions from the Design Professional, uncover and restore Work to provide for Design Professional observation of concealed Work.

D. See other sections of this specification for demolition requirements.

E. Pipe holes in floors and walls shall be core drilled if not sleeved during construction.

1.22 INTERRUPTION OF SERVICE

- A. When work progress makes temporary shutdown of services unavoidable, shutdown shall be coordinated with and approved by Owner so as to cause minimum disruption to established operating routine. Arrange to work as necessary to re-establish service within shortest possible down time. In those instances where the length of time required for the service interruption is not acceptable to the Owner, unless otherwise indicated, furnish and install temporary connections as required to reduce the length of time of service interruption to an acceptable level. Provide advanced notification a minimum one week in advance for approval.

Retain below only if it is applicable to the project. Coordinate LEED points and reference numbers.

1.23 LEED DOCUMENTATION

- A. Contractor to refer to LEED IEQ C4.1 & C4.2 Low-Emitting Materials. Provide submittals showing compliance as follows:
1. Product Data for Credit IEQ 4.1: For adhesives and sealants used, documentation including printed statement of VOC content. Refer to Division 01 Section "Sustainable Design Requirements" for additional procedures governing sustainable design.
 2. Product Data for Credit IEQ 4.2: For paints and coatings used, documentation including printed statement of VOC content. Refer to Division 01 Section "Sustainable Design Requirements" for additional procedures governing sustainable design.

PART 2 - PRODUCTS (Not Applicable to this Section)

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.3 TESTS AND ADJUSTMENTS

- A. Upon completion of the erection of all equipment and all work specified herein and/or shown on approved drawings, or at such times as directed by the Design Professional, this Contractor shall start all apparatus, make necessary tests as directed and as specified herein and make complete adjustments of all items of equipment before acceptance by the Design Professional to whose representative this Contractor shall demonstrate (by performance) all of the various apparatus and equipment.

- B. This Contractor is referred to Section 230593 "Testing, Adjusting, and Balancing for HVAC" for additional information and requirements. Cooperate fully with the Balancing Contractor to achieve a successful balance. Any and all adjustments to equipment including fan sheave replacement shall be the responsibility of this Contractor. Required adjustments shall be made during the course of the balancing procedure; the final balance report must reflect the best possible performance of the systems.
- C. When the Contractor is ready to run capacity tests, he shall notify the Design Professional. When this notice is given, the Design Professional will assume that the Contractor has made preliminary tests and is satisfied that the plant will develop specified and guaranteed capacities. It will be the Contractor's responsibility to furnish any and all instruments required to obtain test data which shall include thermometers, electric meters, pressure gages, etc.
- D. Work under this division of the specifications shall not be considered complete until the Contractor has obtained required inspection, performance tests, made necessary adjustments and has submitted satisfactory evidence of compliance. The Design Professional or his representative will make spot checks to determine the accuracy and completeness of final adjustments. Should spot checks indicate more than a reasonable deviation from design requirements, the Contractor shall repeat tests and adjustments to the satisfaction of the Design Professional.

Include if required by Owner.

- E. After or during one complete heating and cooling season, the HVAC Contractor shall make any minor adjustments that may be necessary to ensure uniform temperatures throughout the spaces.
- F. During the testing and balancing period, this Contractor shall maintain on the job a competent individual thoroughly familiar with all phases of air conditioning, including refrigeration, temperature control, air and water distribution, for as long a period as may be required to thoroughly adjust all of the systems and to demonstrate to the Design Professional that they are functioning properly.

3.4 PUNCHLISTS

- A. From time to time throughout the course of the work, or upon completion of the work the Design Professional may perform site observations resulting in written documentation of deviations in the work from the Contract Documents. In such cases the Contractor shall respond in writing to each and every item on this written documentation stating the specific action taken to remedy the deviation. A response shall be provided by the Contractor for each separate observation. This work shall not be considered complete until such satisfactory written response is received by the Design Professional.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

- B. Each shop drawing is to be labeled with include KSU-Project Number, building or structure name, specification section, nameplate data, model number and efficiency rating along with full load amps for all electrical motors.
- C. Maintenance Manuals:
1. One (1) preliminary review maintenance manual shall be submitted to OUA for review after the Associate has reviewed and approved and this shall be submitted prior to equipment start-up and function testing under the commissioning of the mechanical, electrical, plumbing or fire protection systems. Upon approval by the University and at the completion of the commissioning one (1) final hard copy and one (1) electronic copy on DVD or flash drive in “PDF” (searchable PDF format is required for all possible content or at minimum section dividers of content) format shall be provided at time of signing your contract completion certificates and shall be uploaded into the OAKSCI (if applicable) at that time and the electronic copy is to be provided to OUA prior to release of project retainage.
 2. Maintenance manuals shall include at a minimum the following in addition to that specified earlier:
 - a. Cover sheet with project name, KSU project number, Associate names and prime contractors involved.
 - b. All equipment start-up reports.
 - c. All local suppliers and contact information for supplied equipment and components.
 - d. Equipment and material warranties and guarantees. Provide also in an electronic list in Excel spreadsheet format.
 - e. Final State Inspection sign off forms with associated CPA numbers.
 - f. Training Forms.
 - g. CxA commissioning forms when applicable to project.
 - h. All final submittals shall indicate **actual device provided** not general product information. Clearly indicate all options provided. Submittals to include the Project Name, KSU Project Number, Specification Section, Associated Tag Number if applicable, referenced or drawing number if calling out product.
- D. Draining or Chemical Cleaning of any Closed Loop Chilled Water, Steam and Steam Condensate Systems, Glycol Systems, Closed Loop Heating Water, and Cooling Tower Water Systems to the City of Kent’s sanitary system is prohibited, without filling for a discharge drainage permit. Mandatory two week notice to dump will be required with an approved signed document from the City of Kent. KSU submits required forms to city, however contractor must provide onsite personnel contact information and estimated volume of discharge that will be drained. KSU would prefer that the designing engineers require reclaim methods be implemented versus dumping, unless no other options are possible. Compliance with these requirements will be required in your base of design for any project on the Kent Campus.

END OF SECTION 230500

SECTION 230501 - BASIC MECHANICAL MATERIALS AND METHODS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.
- B. Requirements specified in Division 23 Section "Common Work Results for HVAC" apply to this section.
- C. Requirements of Division 03 specification sections apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of mechanical related work required by this section is indicated on drawings and/or specified in other Division 23 sections.

Retain below if applicable. Coordinate excavation and backfilling with the Architect. Use Paragraph "B" if this contractor is to perform (preferred) or "C" if by the general contractor.

- B. Except as noted in this specification, this Contractor shall do all excavating and backfilling necessary to the work of this Division.
- C. This Contractor is to coordinate all excavating and backfilling required under this Division with General Trades as specified under Division 03.
- D. See specification Division 09 for painting requirements. Coordinate all mechanical painting work required. Coordinate protection requirements for mechanical equipment which could be damaged by paint.

Retain above if Architect is specifying painting, otherwise use paragraph below.

- E. This Contractor shall perform all painting incidental to this work.
- F. Furnish and install all miscellaneous steel required for supports, hangers, anchors, guides, etc., required for installation of equipment and materials furnished and installed under this Division. Steel used in a moist environment shall be hot dipped galvanized unless otherwise noted.

Coordinate concrete requirements with Architect. Select one of the following two paragraphs.

- G. This Contractor shall furnish and install concrete foundations or bases under all equipment that rests on floors in Mechanical Equipment Rooms. Follow drawings and/or manufacturer's literature with regard to design and construction of same.
- H. This Contractor shall provide to the General Trades Contractor dimensions and special requirements for the concrete foundations or bases under all equipment that rests on floors in Mechanical Equipment Rooms. Follow drawings and/or manufacturer's literature with regard to design and construction of same.

Review with Owner and edit accordingly.

- I. This Contractor shall perform all Division 23 related and indicated selective demolition including nondestructive removal of materials and equipment for re-use or salvage as indicated. Unless otherwise indicated, dismantle mechanical materials and equipment made obsolete by these installations. All equipment removed shall be offered to the Owner for his retention. If the Owner elects to retain equipment, it shall be turned over to the Owner at the site. If not, the equipment shall be removed from the premises by this Contractor.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. Concrete Work Codes and Standards: Comply with governing regulations and, where not otherwise indicated, comply with industry standard, in its application to work in each instance.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including the recommended installation method, all in accordance with Division 01 and Section 230500 requirements.

PART 2 - PRODUCTS**Retain below only if this contractor is responsible for concrete work.****2.1 MATERIALS OF DIVISION 23 CONCRETE WORK**

- A. Reinforcing Materials:
 1. Reinforcing Bars: Except as otherwise indicated, provide ASTM A 615, deformed, Grade 40 for size numbers 3 through 18; ASTM A 675, plain, Grade 60, for size number 2; sizes as indicated or required.
- B. Reinforcement Supports: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Provide wire bar type supports complying with CRSI recommendations, unless otherwise indicated.
- C. Concrete Materials:
 1. Portland Cement: ASTM C 150, Type I, except as otherwise indicated.
 2. Aggregates: ASTM C 33, except as otherwise indicated.

- a. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used.
 - b. For rough grouting, provide aggregate which is well graded and 100 percent passing through 3/8" sieve.
3. Water: Clean and free of substances harmful to concrete.

2.2 DESIGN AND PROPORTIONING OF CONCRETE MIXES

- A. General: Design mechanical work concrete as follows, for each 28-day compressive strength class:

Select 4000 psi for supporting large tanks or for beams, 3000 psi for equipment pads and foundations, 2550 psi for filling inertia bases, backfill class for rough backfilling with concrete.

1. 4000 psi Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.35 water/cement ratio.
 2. 3000 psi Class: 500 lbs of cement per cu. yd. (5.25 sacks), and 0.46 water/cement ratio.
 3. 2500 psi Class: 450 lbs. of cement per cu. yd. (4.75 sacks), and 0.54 water/cement ratio.
 4. Backfill Class (Lean Concrete): 375 lbs of cement per cu. yd., (4.0 sacks), and 0.60 water/cement ratio.
 5. Rough Grouting Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.60 water/cement ratio.
- B. Mix for Patching: Where mechanical work requires patching of exposed concrete work which has been cut to accommodate mechanical work, provide concrete patching mix which is identical with mix of work being patched (same cement, aggregates, admixtures and proportioning).

Retain below if excavation is required by this contractor.

2.3 EXCAVATING FOR DIVISION 23 WORK:

- A. Backfill Materials:

1. All backfilling within the building shall consist of an initial 12" layer of sand over the pipe. The remainder of the backfill shall be course interlocking aggregate or limestone screenings.
2. All backfilling outside the building shall be selected dirt, free of large stones.

Include this section below only if mechanical is to provide painting.

2.4 GENERAL DIVISION 23 PAINTING PRODUCT REQUIREMENTS:

- A. All exposed insulation in occupied areas (and elsewhere, as indicated) shall be painted at the time of installation with one coat of water base paint. At the completion of the work

all such insulation shall be given an additional coat of alkyd resin paint of a color to match existing building structure, or as selected by the Architect/Engineer.

- B. All uncovered ferrous pipe, fittings, exposed threads of galvanized pipe, non-factory painted portions of valves, hangers, structural steel, expansion tanks, cooling tower sumps, return air fans, and all other ferrous work shall be thoroughly cleaned and given two coats of alkyd resin paint of a color as selected by the Architect/Engineer.
- C. All uncovered exposed sheet metal in occupied areas (and elsewhere, as indicated) shall be thoroughly cleaned and neutralized and given two (2) coats of alkyd resin paint of a color as selected by the Architect/Engineer.
- D. All general equipment and materials so indicated on the drawings as work to be painted by this contractor shall be thoroughly cleaned and given two (2) coats of a color as selected by the Architect/Engineer.
- E. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

Devoe and Reynolds Co. (Devoe).
Glidden Coatings and Resins, Div. of SCM Corporation (Glidden).
Benjamin Moore and Co. (Moore).
PPG Industries, Pittsburgh Paints (Pittsburgh).
Pratt and Lambert (P & L).
The Sherwin-Williams Company (S-W).

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS, EXCAVATION AND BACKFILL FOR DIV. 23 WORK:

Coordinate below with Architect for Division 02.

- A. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during excavation operations.
- B. Notify proper authorities prior to commencing excavation. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

Delete below if no existing utilities.

- C. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Architect/Engineer and then only after acceptable temporary utility services have been provided.

1. Provide minimum of 48-hour notice to Architect/Engineer, and receive written notice to proceed before interrupting any utility.

Edit above to suit project requirements.

- D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.
- E. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights. Where trenches cross roads, walks, or public thoroughfares, provide suitable barricades and bridges adequately protected by signs or red flags during day and lights at night.
- F. Operate warning lights as recommended by authorities having jurisdiction.
- G. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
 1. Perform excavation within drip-line of large trees to remain by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.
- H. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install mechanical work on frozen excavation bases or subbases.

3.2 EXCAVATING FOR DIVISION 23 WORK:

- A. General: Do not excavate for mechanical work until work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum.
- B. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
- C. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- D. Deep Excavation Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
- E. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

- F. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
- G. Dewatering: Lay no pipe in water. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
- H. Do not allow water to accumulate in excavations. Remove water to prevent soil changes detrimental to stability of subgrades. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
- I. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- J. Excavation for Pavements: Cut surface under pavements as required. Repave all streets or sidewalks disturbed at this Contractor's expense, to recommendations, procedures and satisfaction of the Architect/Engineer and authorities having jurisdiction.
- K. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe.
- L. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups. Any trenches dug below required depth shall be filled to proper depth with sand.
- M. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
- N. For pipes 5" or less in nominal size, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
- O. For pipes or conduit 6" or larger in nominal size, tanks and other mechanical work indicated to receive subbase, excavate to subbase depth indicated, or, if not otherwise indicated, to 6" below bottom of work to be supported.
- P. Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam, condensate, drainage) so top of piping is not less than 3'-6" below finished grade.

3.3 PREPARATION OF FOUNDATION FOR BURIED PIPING:

- A. Grade trench bottom to provide smooth, firm, stable, and rock-free foundation throughout length of piping.
- B. Remove unstable, soft, and unsuitable materials at surface on which piping is to be laid, and backfill with clean material as specified.
- C. Shape bottom of trench to fit bottom of piping. Fill unevenness with tamped-sand backfill. Dig bell holes at each pipe joint to relieve bells of loads and to ensure continuous bearing of pipe barrel on foundation.

- D. Care shall be exercised to keep interior of buried piping free of dirt and foreign matter.

3.4 BACKFILLING:

- A. Backfill with finely-graded subbase material to 6" above wrapped, coated, and plastic piping and tanks, and to centerline of other tanks.
- B. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.
- C. Backfill simultaneously on opposite sides of mechanical work, and compact simultaneously; do not dislocate work from installed positions.
- D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (% of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.
 - 1. Lawn and Landscaped Areas: 85% of cohesive soils; 90% for cohesionless soils.
 - 2. Paved Areas, Other Than Road ways: 90% for cohesive soils; 95% for cohesionless soils.
 - 3. Roadways: 90% for cohesive soils; 95% for cohesionless soils.
- E. Backfill to elevations matching adjacent grades, at time of backfilling excavations for mechanical work.

3.5 DISPOSAL OF EXCESS AND WASTE EXCAVATION MATERIALS:

- A. Removal from Owner's Property: Remove excess excavated material, trash, debris and waste materials and dispose of it off Owner's property.

3.6 INSTALLATION OF CONCRETE WORK

Coordinate concrete work in this section with Division 03 Section "Cast-In-Place Concrete" or "Miscellaneous Cast-In-Place Concrete."

Retain below when seismic restraints are required. Coordinate below with Division 22 Sections specifying equipment. Indicate dowel rod quantity, size, and spacing on drawings.

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions [**and according to seismic codes at Project**].
- B. Formwork:
 - 1. General: Design, construct and maintain formwork to support vertical and lateral loads including pressure of cast-in-place concrete. Construct formwork so that formed concrete will be required size and shape and in required location. Construct with joints which will

not leak cement paste. Form sides and bottoms of concrete work, except where clearly indicated to be cast directly in excavation or against other construction, or on grade or prepared subgrade. Design and construct forms for easy removal without damage to concrete and other work.

- a. Install chamfer strips at external corners of exposed concrete work.
- b. Construct forms to retain equipment anchor bolts in accurate locations during placement of reinforcing steel and concrete. Use templates furnished by equipment manufacturers to locate anchor bolts or, where not furnished, locate by accurate measure from certified setting diagrams.

C. Placing Reinforcement:

1. General: Comply with requirements and recommendations of specified standards, including "Placing Reinforcing Bars" by CRSI. Place bars where indicated and support to prevent displacement during concrete placement, using appropriate reinforcement supports, properly spaced and wire tied to reinforcing bars.
 - a. Place reinforcement to obtain at least minimum recommended coverages for concrete protection. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which would reduce bond with concrete.

D. Placing Concrete:

1. Wet wooden forms which have been coated with compound, immediately before concrete, and remove excess water from forms.
2. Strength-Class Application: Comply with the following general application requirements.
 - a. Backfill: Provide backfill class (lean concrete).
 - b. Miscellaneous Supported Work: Provide 3000 PSI class for curbs, pads, and similar supported work.
 - c. Concrete Fill: Provide 2500 PSI class for filling structural steel foundation frames and for filling similar large-volume units.
 - d. Concrete Grout: Provide rough grouting class for filling voids to be grouted which are too small to be filled effectively with 2500 PSI class concrete.
 - e. Patching General Concrete Work: Match concrete being patched.
3. Deposit concrete continuously or in layers of thickness which will result in no concrete being placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within section. If section cannot be placed continuously, provide construction joints. Deposit concrete as nearly as practicable in its final location, so as to avoid segregation due to rehandling or flowing.
4. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures complying with recommended practices of ACI 309; eliminate voids in work.

5. Cold Weather Placement: Comply with ACI 306. Do not use frozen materials or materials containing ice and snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. When air temperature has fallen or is expected to fall below 40 deg F (4.4 deg C), heat water and aggregates uniformly before mixing, as required to obtain concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (26.7 deg C), at time of placement. Protect concrete work from physical damage and reduced strength resulting from frost, freezing actions, or low temperatures.
6. Finishing Horizontal Surfaces: Float and trowel horizontal (top) surfaces to level, smooth, uniform textured, dense finish, where surface is to remain exposed or receive coating, membrane or other thin-set finish. Otherwise, leave struck-off surface undisturbed; except scratch surfaces which are to receive concrete or mortar topping or setting bed, by raking with a stiff broom.
7. Depress top of concrete backfill sufficiently so that supported work can be set in bed of mortar or sand as indicated.
8. Curbs: Provide monolithic finish on interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to hard, dense finish with corners, intersections and terminations slightly rounded and coved.
9. Surface Repairs:
 - a. Unexposed Surfaces: Repair significantly damaged and honeycombed areas, and remove major projections and fins where forms have been removed.
 - b. Exposed Surfaces: On formed surfaces which are to be exposed, including those to be coated or covered with membrane or other thin-set applied finish, repair and patch form-tie holes and damaged and honeycombed areas, filling voids with grout and completely removing fins and other projections.

E. Concrete Curing and Protection;

1. General: Protect freshly placed concrete from drying and excessively cold and hot temperatures, and maintain in moist condition at relatively constant temperature for period of time necessary for hydration of cement, proper hardening, and achievement of strength requirements as specified.

F. Miscellaneous Concrete Work:

1. Concrete Grouting:
 - a. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
 - b. Clean surfaces that will come into contact with grout.
 - c. Provide forms as required for placement of grout.
 - d. Avoid air entrapment during placement of grout.
 - e. Space approximately 1" thick between bottom of equipment and top of concrete foundation or base which remains after shimming, shall be filled completely with grouting. Grout shall be made up with sand and cement designed for the purpose which does not shrink on setting up.
 - f. Grout openings and recesses as indicated, in and around plumbing work and other work which penetrates or adjoins plumbing concrete work, using rough grouting class of concrete mix.

- g. Provide formwork where required, and tamp, screed and trowel surfaces.
 - h. Place grout on concrete bases and provide smooth bearing surface for equipment.
 - i. Place grout around anchors.
 - j. Exposed surface of grouting shall be finished to make a neat appearance.
 - k. Cure grout as specified for concrete work.
 - 2. Concrete Bases: In the absence of more specific information, either on drawings, or manufacturer's literature, the bases shall be level, shall have a minimum height above finished floor of 4" and extend 3" beyond the skids, feet or bed plate of the item of equipment.
 - 3. Concrete pads, beams, pedestals, or saddles placed in existing structures shall be mounted securely to the original substrate with anchor bolts.
- G. General Concrete Clean-Up: Upon completion of concrete work, clean excess concrete from adjacent areas and surfaces. Remove excess concrete by proper methods of washing or scraping, using care not to scratch or otherwise damage finished surfaces.

3.7 SURFACE PREPARATION FOR PAINTING:

- A. General: Clean surfaces before applying paint products. Remove oil and grease prior to mechanical cleaning. Comply with paint products manufacturer's instructions for surface cleaning and preparation. Remove surface-applied accessories which are not to be painted, and reinstall after completion of painting. Protect non-removable items not to be painted, by covering with paper or plastic film.
- B. Ferrous Metal Surfaces: Clean and remove mill scale and loose rust on surfaces which are not zinc-coated or shop/factory prime coated.
- C. Zinc-Coated Surfaces: Clean with non-petroleum based solvent. Wash with copper sulfate solution and flush with water, unless surface has been pretreated, or unless treatment is not recommended by manufacturer of prime coat.

3.8 PAINT SYSTEM APPLICATION:

- A. Environmental Conditions, Painting Work: Comply with governing regulations concerning use of and conditions for application of paint. Comply with manufacturer's recommendations and instructions. Do not apply paint in unfavorable conditions of temperature, moisture (including humidity) or ambient contamination (dust and other pollutants).
- B. Mixing: Comply with manufacturer's recommendations for mixing or stirring paint products immediately before application.
- C. Application Limitations: Except as otherwise indicated, paint every accessible surface of each unit of work indicated to be painted, regardless of whether in location recognized as "concealed" or "exposed".

Delete from and insert into the following list of omissions to satisfy project requirements.

1. Omit painting on surfaces located in service shafts and above non-removable ceilings and in similar places where in the opinion of the Engineer, space is too limited or services are too congested to allow access for painting.
2. Omit painting on machined sliding surfaces and rotating shafts of equipment, and on nonferrous finished metals including chrome plate, stainless steel, special anodized aluminum, brass/bronze and copper, and on plastics and similar finished materials, except where specifically indicated to be color-coded by painting.
3. Omit painting on required name plates, labels, identification tags, signs, markers, printed instructions, performance ratings, flow diagrams and similar text and graphics, located within the scope of work indicated to receive paint application.
4. Omit specified prime coat of paint system for metal surfaces where surface has shop-applied prime coat of equivalent quality. Apply prime coat on other surfaces to be painted; comply with paint manufacturer's instructions for prime coating where not otherwise indicated. Apply additional prime coats where suction spots or unsealed areas appear.

D. General Application Requirements: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate, for type of material being applied, and for ambient conditions. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Apply paint at edges, corners, joints, welds and exposed fasteners in manner which will ensure dry-film thickness equal to that of flat surfaces. Allow sufficient time between successive coats for proper drying (comply with manufacturer's drying instructions).

1. Number of Coats: Number indicated is minimum number; apply as many coats as are necessary to comply with dry-film thickness requirements.
2. Coating Thickness: Apply uniform coats to produce dry-film thickness indicated or, if not otherwise indicated, apply paint without thinning in application thickness recommended by manufacturer for each coat.
3. Smooth Finishes: Except as otherwise indicated, apply paint in smooth finish without noticeable texture, cloudiness, spotting, holidays, laps, brush marks, runs, sags, ripples, ropiness and other surface imperfections.
4. Textured Finishes: Where indicated, roll and redistribute paint of final coat to even texture. Match adjoining texture paint finishes if any, and roll to eliminate evidence of roller or lap marks and other unevenness and imperfections.

3.9 PAINTING CLEAN-UP AND PROTECTION:

A. General Painting Clean-Up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day. When directed by Architect/Engineer, retain paint containers from application of coatings on particular unit or area of work, until average dry-film thickness has been calculated.

Delete below if final cleaning is not done by painter. This may be the general contractor's responsibility.

1. Spattered Surfaces: Upon completion of painting work, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.
2. Protection: Protect work of other trades, whether to be painted or not, against damage by painting work. Correct damage by cleaning, repairing or replacing and repainting as directed. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings installed for protection of work not to be painted, after completion of painting operations. At completion of work by other trades, touch-up and restore damaged or defaced painted surfaces.

Retain below if relevant.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

Delete below when demolition and / or reference to Division 01 is not included in the project.

3.11 SELECTIVE DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching".
- B. Refer to Division 01 Specifications for outline of recycling and salvaging materials, procedures, and overall diversion goals for demolition.
- C. General: demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved. Remove associated hangers, supports, miscellaneous steel. Disturbed remaining insulation to be repaired to match existing with vapor barrier.
- D. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
- E. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
- F. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- G. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- H. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

- I. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- J. Where walls are removed and sleeves are left on mechanical piping, remove the sleeves and associated insulation and install new insulation.
- K. Demolition of Refrigerant-Containing Equipment and Piping:
 - 1. Demolish, remove and disconnect refrigerant-containing equipment and piping as indicated and required. Prior to such work, recover without venting all refrigerant in compliance with Environmental Protection Agency (EPA) Rule 40 CFR Part 80. Recovery shall be performed by certified technicians in accordance with that rule. After recovery, the Contractor shall advise the Owner of the amount of refrigerant recovered and the Owner shall advise the Contractor whether he wishes to recycle or reclaim the refrigerant. If so, the Contractor shall turn the recovered refrigerant over to the Owner at the construction site in approved, sealed containers for recycling at the Owner's expense. If the Owner does not wish to retain the refrigerant, the Contractor shall remove and legally dispose of all refrigerant.
 - 2. Provide Owner with certification of recovery and disposal of refrigerant. This includes documentation of refrigerant type, charge pressure, reclaim amount, and method for disposal.
- L. Exposed piping indicated to be removed back to the active line and capped. No dead legs longer than 5' will be permitted on active lines. No dead legs which can trap condensate shall be permitted on steam lines.
- M. Protect adjacent materials indicated to remain.
- N. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
- O. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- P. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for relocation or storage.
- Q. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- R. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, supports, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.
 - a. Unless otherwise indicated, piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove

materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

2. Perform cutting and patching required for demolition in accordance with requirements of other sections of this specification.
- S. The use of explosives in this work is prohibited.
- T. Refer to Division 01 Specifications for outline of recycling and salvaging materials, procedures, and overall diversion goals for demolition.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Backfill and Fill Material: Backfill requirements at road and parking lot crossings shall meet the City of Kent's standards for backfilling. City of Kent's approval is not required unless City owned. Review with OUA if any questions.
- C. Miscellaneous Metals: All outdoor miscellaneous metal equipment supports shall be galvanized steel. Spray-on galvanizing shall be applied to all disturbed areas. All indoor miscellaneous metal equipment supports shall be black iron, primed and painted or galvanized.
- D. All materials shall be non-asbestos containing.
- E. All firestop material shall be painted to match adjacent wall surfaces in visible public spaces.
- F. Obtain welding permit from KSU OUA.

KSU DESIGNERS NOTES:

1. **Wherever possible, abandoned piping and ductwork shall be removed back to the main and capped**

END OF SECTION 230501

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings, and further described in other specification sections.

1.3 SUBMITTALS

- A. Submit product data for motors and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections. Submit compliance to referenced standards and efficiencies.
- B. Free standing motors and other electrical components not submitted under other sections shall require separate submittal.
- C. Submit manufacturer's electrical requirements for power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

1.4 QUALITY ASSURANCE

- A. National Electrical Manufacturer's Association (NEMA) Standards MG 1: Motors and Generators, "Energy Efficient Design".
- B. NEMA Standard 250: Enclosures for Electrical Equipment
- C. Comply with National Electrical Code (NFPA 70). Provide motors specified in this section that are "Listed and Labeled" as defined in Article 100.

1.5 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
1. Motor controllers.
 2. Torque, speed, and horsepower requirements of the load.
 3. Ratings and characteristics of supply circuit and required control sequence.
 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Baldor
 2. General Electric
 3. Lincoln
 4. Allis-Chalmers
 5. Reliance Electric
 6. WEG
- B. Comply with NEMA MG 1 unless otherwise indicated.

Retain option below for severe duty motors.

- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
1. Motors ½ HP and Larger: Polyphase.
 2. Motors Smaller than ½ HP: Single phase.
 3. Frequency Rating: 60 Hz.
 4. Voltage Rating: Determined by voltage of circuit to which motor is connected.
 5. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.
 6. Temperature Rise: Match insulation rating, unless otherwise indicated.
 7. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
 8. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

9. Enclosure Type: Shall be open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, guarded drip-proof motors where exposed to contact by employees or building occupants, and weather protected Type I for outdoor use, Type II where not housed.
10. Overload Protection: Built-in thermal overload protection rated at 115% of full load motor and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
11. Efficiency: Motors shall have a minimum efficiency as scheduled in accordance with NEMA Standard MG-1, most current table for high efficiency motors. Motors must meet or exceed the guaranteed minimum of this standard and shall be nameplated with the nominal value.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage, unless otherwise indicated.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating, unless otherwise indicated.
- I. Insulation: Class F.
- J. Code Letter Designation:
 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Provide with integral motor bearing current protection (AEGIS) rings.

Retain option below only if project requires severe duty motors based on environmental conditions

- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
- D. Source Quality Control: Perform the following routine tests according to NEMA MG 1:
1. Measurement of winding resistance.
 2. No-load readings of current and speed at rated voltage and frequency.
 3. Locked rotor current at rated frequency.
 4. High-potential test.
 5. Alignment.

2.5 SINGLE-PHASE MOTORS

- A. As indicated in equipment specification sections, or if not indicated as selected by manufacturer from one of the following to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split phase start, capacitor run.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Service Factor: 1.15.
- D. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading used on belt connected motors. Sealed, prelubricated sleeve bearings for other single-phase motors..
- E. Motors 1/20 HP and Smaller: Shaded-pole type.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range, unless otherwise noted.

PART 3 - EXECUTION (Not Applicable)

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 SHAFT GROUNDING RINGS (ALL MOTORS WITH VARIABLE FREQUENCY DRIVES)

- A. Shaft grounding rings (SGR) shall be factory installed inside the motors by the manufacturer wherever possible. SGR's may be field installed by installing contractor subject to Engineer's approval. Provide AEGIS SGR Colloidal Silver Shaft Coating, or approved equal, on shafts prior to rings installation, per SGR manufacturer's recommendations, after first cleaning shafts.
- B. Install and test SGR's in accordance with manufacturer's recommendations. Install the SGR so that the aluminum frame maintains an even clearance around the shaft. Conductive microfibers shall be in full circumferential contact with conductive metal surface of the shaft. Do not use thread lock to secure the mounting screws as it may compromise the conductive path to ground. If thread lock is required, use a small amount of EP2400 AEGIS Conductive Epoxy, or approved equal, to secure the screws in place.
- C. Shafts shall be clean and free of any coatings, paint, or other nonconductive material (clean to bare metal). Depending upon the condition of the shaft, it may require using emery cloth or Scotch-Brite. If the shaft is visibly clean, a non-petroleum based solvent may be used to remove any residue.
- D. Check the conductivity of the shaft using an ohm meter.
 - 1. Ohms test: Place the positive and negative meter leads on the shaft at a place where the microfibers will contact the shaft. Each motor will have a different reading but in general one should have a maximum reading of less than 2 ohms. If the reading is higher, clean the shaft again and retest.
- E. After motors with SGR are fully installed in the field (in equipment, assemblies, or individually), for both factory-installed-SGR and field-installed-SGR cases, test for a conductive path to ground using an Ohm meter.
 - 1. Place one probe on metal frame of SGR and one probe on motor frame.
 - 2. Motor must be grounded to common earth ground with variable frequency drive according to applicable standards.
 - 3. Verify that SGR installations and test readings comply with SGR manufacturer's requirements.
 - 4. Shaft voltage testing and verification of the proper installation of the AEGIS Bearing Protection Ring and its effectiveness can be accomplished by testing the motors for shaft voltages using a digital oscilloscope that is 100-Mhz or faster.
 - 5. An AEGIS Shaft Voltage Test Probe is attached to the oscilloscope probe end which is then placed on the machine's shaft allowing for the "real time" measurement of machines as they are operating under PWM IGBT VFD control.

4.2 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. PRODUCTS:
1. All electrical components shall be UL labeled.
 2. Noise Rating: Motors shall be of "premium" efficiency and shall exceed mandated government efficiencies. All motors shall employ bearings for a "quiet" noise rating.
 3. Efficiency: "Energy Efficient" motors shall be of premium efficiency as scheduled in accordance with IEEE Standard 112, test method "B".
- C. INSTALLATION:
1. All electrical installations shall comply with the Division 26 specifications and with the National Electric Code.

KSU DESIGNERS NOTES:**1. Motors:**

- a. 1/3 HP and below use 120V/1 Phase/60Hz. (Unless reviewed with KSU/OUA)
- b. 1/2 HP and above use 208, 230 or 460V/3 Phase/60HZ. (Unless reviewed with KSU/OUA)
- c. Associate to provide info on efficiency and motor types, nameplate data to OUA for review.
- d. Harmonics and lubrication shall be addressed. Motor brake HP, RLA, LRA shall be indicated on the drawing schedules.
- e. All motors shall have a minimum service factor of 1.15 and be designed for non-overloading use.
- f. Motors exposed to wet locations shall be TEFC or meet NEC requirements, whichever is more stringent.
- g. "AEGIS" Type Shaft grounding technology shall be applied to all motors driven by VFDs. This applies to pumps, fans, and other systems on VFD driven type of systems. Review other system if base of design is not around AEGIS.

END OF SECTION 230513

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

Retain only relevant sections to project below.

- A. Section Includes:

1. Metal, compensator packless expansion joints.
2. Flexible-hose packless expansion joints.
3. Metal-bellows packless expansion joints.
4. Externally pressurized metal-bellows packless expansion joints.
5. Alignment guides and anchors.
6. Pipe loops and swing connections.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Expansion Joint Manufacturer Association Certification (EJMA).
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Provide expansion compensation, of style specified, where indicated for piping systems, suitable for piping service fluids, materials, working pressures, and temperatures selected by Installer to suit intended service. Select expansion compensation to provide 200% absorption capacity of piping expansion between anchors.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flex-Hose Co., Inc.
 2. Engineered Flexible Products, Inc.
 3. Flexonics Div.; UOP, Inc.
 4. General Rubber.
 5. Hyspan Precision Products, Inc.
 6. Keflex HVAC Products.
 7. Mason Industries, Inc.
 8. Metraflex Company (The).
 9. Senior Flexonics Pathway.

Retain and edit for expansion joint types applicable to project.

2.2 PACKLESS EXPANSION JOINTS

- A. Metal, Compensator Packless Expansion Joints **MCEJ-01**:
1. Minimum Pressure Rating: **[150 psig]** **[300 psig]**, unless otherwise indicated.
 2. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid flow by an internal pipe sleeve and external housing.
 3. Basis of Design: Hyspan 8500 Series.
 4. Joint Axial Movement: **[2]** **[3]** inches of compression and 1/2 inch of extension.
 5. Configuration for Copper Tubing: Multi-ply, stainless bellows with copper pipe ends.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Threaded or Sweat.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Flanged.
 6. Configuration for Steel Piping: Multi-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged.
 7. Warranty: The product is warranted to be free from defects in material and workmanship, and to be leak-free for a period of three (3) years from the date of shipment.
- B. Flexible-Hose Packless Expansion Joints **FHEJ-01**:

1. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
2. Basis of Design: Hyspan or Engineered Flexible Products.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with threaded end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
 - b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with flanged end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with flanged end connections.
 - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

C. Metal-Bellows Packless Expansion Joints **MBEJ-01**:

1. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
2. Basis of Design: Hyspan 8500 Series.
3. Type: Circular, corrugated bellows [with external tie rods].
4. Minimum Pressure Rating: [150 psig] [175 psig] [200 psig], unless otherwise indicated.
5. Configuration: [Single joint] [Single joint with base] [and] [double joint with base] class(es), unless otherwise indicated.
6. Expansion Joints for Copper Tubing: [Single-] [or] [multi-] ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Threaded or Sweat.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
 - c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.
7. Expansion Joints for Steel Piping: [Single-] [or] [multi-] ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

D. Externally Pressurized Metal-Bellows Packless Expansion Joints **EPEJ-01**:

1. Minimum Pressure Rating: [150 psig] [300 psig], unless otherwise indicated.
2. Basis of Design: Hyspan 3500 Series.
3. Description:
 - a. Totally enclosed, externally pressurized, three-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve with internal and external guides.
 - b. Carbon-steel housing.
 - c. Drain plugs and lifting lug for the NPS 3 and larger.
 - d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
 - e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
 - f. Joint Axial Movement: [4 inches] [6 inches] [8 inches] <Insert compression limit> of compression and [0.75 inch] [1 inch] [2 inches] <Insert extension limit> of extension.
4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.
6. Warranty: The product is warranted to be free from defects in material and workmanship, and to be leak-free for a period of five (5) years from the date of shipment.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides **AG-01**:

1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Size guide and sliders to clear pipe and insulation (if any), and cylinder. Provide guides of the length recommended by manufacturer to allow for indicated travel.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

Retain below references to gaskets on steam and / or hydronic systems.

2.4 GASKETS

- A. Refer to Specification Section 232113 Hydronic Piping for gasket types to be used on hydronic systems.
- B. Refer to Specification Section 232213 Steam and Condensate Piping for gasket types to be used on steam systems.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

- A. General: Install expansion joints where indicated, and elsewhere as determined by Installer for adequate expansion of installed piping system. Install in accordance with manufacturer's instruction. Provide pipe anchors and pipe alignment guides as indicated, and in accordance with manufacturer's recommendations. Align units properly to avoid end loading and torsional stress.
- B. Install expansion joints of sizes matching sizes of piping in which they are installed.

- C. Install packed-type expansion joints with packing suitable for fluid service.
- D. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- E. Install rubber packless expansion joints according to FSA-PSJ-703.
- F. Provide torque testing on bolts including written account of procedures and levels used.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least **[five] <Insert number>** pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least **[four] <Insert number>** pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least **[four] <Insert number>** pipe fittings, including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

Coordinate number, locations, and spacing of guides and anchors with manufacturer.

- B. Install **[one] [two]** guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than **[four] <Insert number>** pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.

2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

KSU DESIGNERS NOTES:

1. Evaluate the need on all projects for at a minimum the following systems: steam piping, steam safety relief piping, heating water systems greater than 120 Deg F, generator exhaust, steam condensate, excessive runs of chilled water.
2. Steam vents, or any safety relief vents shall be designed for thermal expansion thru roof structures and shall be designed for ventilation at building/roof penetrations. Penetration and curb details shall be required in all designs and shall be reviewed with OUA for final approval.
3. Expansion loops are preferred, when possible, to eliminate maintenance requirements. All designs shall include full dimensional detailing, placement of slides and anchor points. All associates shall submit expansion loop calculation for OUA records.
4. Expansion loops and joints may require significant forces to be restrained at anchors and guides. Be sure to coordinate these and the structural implications with a structural engineer.
5. Expansion devices, when required, shall be reviewed with OUA. Consultant and manufacturer shall include as part of design all expansion calculations. Flanged packed expansion joint is preferred; the less costly externally pressurized joint design should be reviewed with OUA prior to approval.
6. Discuss preferred options with OUA.
7. All expansion devices shall be provided with design installation diagrams/details with performance information in addition to being scheduled and specified. Designs shall locate all anchors, guides and mounting devices.
8. Preferred manufacturers are: Metraflex, Hyspan, Keflex, (Victaulic is not acceptable and will not be specified for this use)

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.
5. Mechanical System Sound Stopping.
6. Mechanical System Penetration Seals.

- B. Related Requirements:

Leave Paragraph below if included in specifications

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 DESCRIPTION OF WORK

1. Furnish and install sound stopping around penetrations or mechanical materials and equipment.
2. Furnish and install fire and smoke penetration seals around penetrations of mechanical materials and equipment through fire or smoke barriers, floors and foundation walls.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Fire and Smoke Sealers: For each type of installation provide corresponding assembly detail complying with the current NFPA, ASTM E814, and by Underwriters Laboratory requirements.
- C. Mechanical System Penetration Seals (Firestopping): Submit the following:
 1. Shop drawings showing each condition requiring penetration seals in dictating proposed UL systems materials, anchorage, methods of installation, and actual adjacent construction.

2. A copy of UL illustration of each proposed system indicating manufacturer approved modifications.
3. Manufacturer's specifications, recommendations, installation instructions and maintenance instructions.
4. Tested firestop systems engineering judgement.

1.5 QUALITY ASSURANCE

- A. The firestopping systems are to be installed by experienced, manufacturer trained, and UL certified or FM certified personnel.
- B. All firestopping material is to be provided from a single manufacturer for all applications.
- C. Consult manufacturer's technical experts for assistance in selective appropriate firestop system for each application.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- D. Molded non-conductive, high impact resistant HDPE sleeves (for installations less than 150°F) similar to Proline CS – Century Line Sleeve or Westlantic Tech Corp Wall Sleeves WA. Provide with puddle flange (water stop ring) configuration for mechanical sleeve seal installations.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Flexicraft.
 4. Link-Seal / Thunderline Corp. / Garlock Piping Technology.
 5. Metraflex Company (The).
- B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
3. Sealing Elements: EPDM-rubber for systems up to 250°F interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size. Pressure plates to be composite plastic.
4. Sealing Elements: High-temperature-silicone for systems up to 400°F with interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size. Pressure plates to be coated carbon steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
6. Concrete Wall Penetrations: All concrete wall penetration sleeves shall have a puddle flange (water stop ring) configuration.

2.3 GROUT

- A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, mildew resistant, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer.
- B. Install sleeves accurately centered on pipe runs.
- C. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but no less than 2 pipe sizes larger than piping run.
- D. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for insulation installation.

- E. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 2" above level floor finish, 3/4" above floor finish sloped to drain, and flush with floor in other areas.
- F. Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves.
- G. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- H. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

Retain below if sleeves are not required for core-drilled holes.

- 1. Sleeves are not required for core-drilled holes.
- I. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

Retain below if sleeves are not required for holes in slabs formed by PE or PP molded sleeves.

- 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
- 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- 3. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.

Delete references to Division 07 if not applicable.

- J. Install sleeves for pipes passing through interior partitions and slabs as they are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
 - 4. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - 5. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - 6. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - a. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - b. Seal space outside of sleeve fittings with grout.
 - 7. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.
 - a. Refer to Division 07 Section "Joint Sealants" for materials and installation.

- K. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- L. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- M. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- L. Refer to Division 07 Section "Penetration Firestopping" for materials.**
- N. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials.

Leave Paragraph below if included in specifications

1. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building. Coordinate installation of sleeve prior to pouring walls so that water stop / sleeve assembly is within poured wall on new installations. If holes are core drilled through existing walls, mechanical sleeve seal shall seal up against cored hole.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron sleeves.
 - b. Piping NPS 6 and Larger: Cast-iron pipe sleeves.
2. Exterior Concrete Walls Below Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron pipe or high density polyethylene sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs Above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Steel pipe sleeves.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

3.5 HVAC SYSTEM SOUND STOPPING

- A. Where pipes or ducts or other components of Division 22 work pass through non-fire rated walls or floors, but walls which extend from horizontal structure to structure, provide sound stopping between such mechanical work and the building structure intended to reduce the transmission of sound from one side of the wall to the other.
- B. Sound stopping of pipes in sleeves shall consist of sealing the outside of the sleeve with caulking and the inside with an insulating material.
- C. Sound stopping of pipes or ducts without sleeves shall consist of packing the cavity around the penetration with an insulating material and sealing the opening with approved sealant or plaster.
- D. Insulating materials shall be non-asbestos and non-friable, and shall have a flame spread rating of no more than 25 and a smoke developed rating of no more than 50.

3.6 HVAC SYSTEM PENETRATION SEALS

- A. Where pipes or ducts or other components of Division 23 work pass through fire or smoke rated walls or floors, provide non-asbestos seal assemblies classified by UL to provide fire barriers equal to the time rating of the construction being penetrated, with materials that comply with applicable codes and that have been tested in accordance with UL 1479 or ASTM E-814.
- B. Install penetration seal materials in accordance with printed instructions of the UL Building Materials Directory and in accordance with manufacturer's instructions. Seal all holes or voids made by penetrations. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor.
- C. The contractor shall provide submittal data on each installation type for approval by the Associate.
- D. Fire and smoke sealing systems shall be tested in accordance with the appropriate current NFPA ASTM E 814 and by Underwriters Laboratories requirements.
- E. All materials shall be non-asbestos containing.
- F. All firestop material shall be painted to match adjacent wall surfaces in visible public spaces.
- G. Hold a pre-installation meeting with General associated trades and Owner. Review contractor inspection guidelines.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

- B. Standard sealant manufacturer colors shall be submitted to the Associate for selection, and to KSU OUA for approval. Sealant to be non-asbestos containing.
- C. All firestop material shall be painted to match adjacent wall surfaces in visible public spaces.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Escutcheons.
- 2. Floor plates.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel or brass with polished, chrome-plated finish and spring-clip fasteners.
- D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

- 1. Escutcheons for New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall:
 - 1) One-piece, deep pattern with spring-clip fasteners.
- b. Chrome-Plated Piping:
 - 1) One-piece cast brass.
- c. Insulated Piping:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
- e. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
- f. Bare Piping in Unfinished Service Spaces:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.
- g. Bare Piping in Equipment Rooms:
 - 1) One-piece steel or cast brass.
 - 2) Split-plate, stamped steel or cast brass with concealed hinge.

- 2. Escutcheons for Existing Piping to be split-plate, stamped steel with concealed hinge for the following:

- a. Chrome-Plated Piping.
- b. Insulated Piping.
- c. Bare Piping at Wall and Floor Penetrations in Finished Spaces.
- d. Bare Piping at Ceiling Penetrations in Finished Spaces.
- e. Bare Piping in Unfinished Service Spaces.
- f. Bare Piping in Equipment Rooms.

- 3. Escutcheon Finishes:

- a. Furnish pipe escutcheons with chrome finish for occupied areas, prime paint finish for unoccupied areas.

- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with inside diameter to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 SUPPLEMENTAL REQUIREMENTS

- A. General: Provide pipe escutcheons on all pipes passing through floors and all pipes passing through walls or ceilings in exposed areas with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with chrome finish for occupied areas, prime paint finish for unoccupied areas.
- B. Pipe Escutcheons for Moist Areas including Equipment Rooms: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
- C. Pipe Escutcheons for Dry Areas: Provide chrome plated sheet steel escutcheons, solid or split hinged.
- D. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole and is flush with adjoining surface.

END OF SECTION 230518

KSU DESIGNERS NOTES:

1. Coordinate finished with KSU and Architect. Specification as is requires all exposed penetrations in occupied areas to be chrome plated and prime paint finish for unoccupied areas.

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Liquid-in-glass thermometers.
- 2. Thermowells.
- 3. Dial-type pressure gages.
- 4. Gage attachments.
- 5. Sight flow indicators.

- B. Related Requirements:

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 THERMOMETERS, THERMOWELLS, AND PRESSURE GAUGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- Ashcroft
 - Marshalltown Instruments, Inc.
 - Taylor
 - 3M
 - Trerice (H.O.) Co.
 - Weiss Instruments, Inc.

2.2 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
 2. Case: Cast aluminum or high density plastic 9-inch nominal size unless otherwise indicated.
 3. Case Form: Adjustable angle unless otherwise indicated. Unit to have 180 deg adjustment in vertical plane, 360 deg adjustment in horizontal plane, with locking device.
 4. Tube: Glass with magnifying lens and blue or red organic liquid.
 5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in 2 deg F.
 6. Window: Glass.
 7. Stem: Copper-plated steel, or brass Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

- A. Thermowells:
1. Standard: ASME B40.200.
 2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
 3. Material for Use with Copper Tubing: CNR (copper nickel (90-10)) or CUNI (copper nickel (70-30)).
 4. Material for Use with Steel Piping: Stainless Steel.
 5. Type: Stepped shank unless straight or tapered shank is indicated.
 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 8. Bore: Diameter required to match thermometer bulb or stem.
 9. Insertion Length: Length required to match thermometer bulb or stem.

10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled (where maximum system temperature is less than 160°F) drawn steel on all vibrating equipment; minimum 4-1/2" diameter above 6'- 0" above floor, 3-1/2" below 6'-0" above floor.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Plastic.
9. Ring: Stainless steel.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of steel pipe with NPS 1/4 pipe threads.
- C. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

2.6 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Dwyer Instruments, Inc.
 2. Emerson Process Management; Rosemount Division.
 3. Ernst Flow Industries.
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 150 psig.

- E. Minimum Temperature Rating: 200 deg.
- F. End Connections for NPS 2 and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- H. Install valve and syphon fitting in piping for each pressure gage for steam.
- I. Install flow indicators in piping systems in accessible positions for easy viewing.
- J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- K. Install pressure gages in the following locations:
 - 1. Inlet and discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3. Suction and discharge of each pump.
 - 4. Inlet and outlet of each heat exchanger.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Industrial-style, liquid-in-glass type thermometers to be installed at inlet and outlet shall be located at the following:
 - 1. Each hydronic zone
 - 2. Each hydronic boiler.
 - 3. Each chiller.
 - 4. Each hydronic coil in air-handling units and built-up central systems.
 - 5. Each hydronic heat exchanger.
 - 6. Each hydronic heat-recovery unit.
 - 7. Each thermal-storage tank.
- B. Thermometer stems shall be of length to match thermowell insertion length.
- C. Thermometers installed with improper ranges will be required to be replaced by the contractor at no additional costs after system commissioning is complete.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.
- B. Scale Range for Condenser-Water Piping: 0 to 150 deg F.
- C. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F.
- D. Scale Range for High Temperature Heating, Hot-Water Piping: 50 to 550 deg F.
- E. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Sealed, direct mounted, metal case pressure gages to be installed at the following locations:
 - 1. Inlet and outlet of each hydronic system with medium greater than 160°F and steam pressure-reducing valve.
- B. Liquid-filled, direct-mounted, metal case pressure gauges to be installed at the following locations:
 - 1. Inlet and outlet of each hydronic system with medium less than 160°F.

- C. Gages installed with improper ranges will be required to be replaced by the contractor at no additional costs after system commissioning is complete.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

Select proper range for relevant utilities below. Select gages so typical operating condition is near the midpoint of the scale.

- A. Scale Range for Chilled-Water Piping:
1. 0 to 30 psi.
 2. 0 to 100 psi.
 3. 0 to 160 psi.
 4. 0 to 200 psi.
- B. Scale Range for Condenser-Water Piping:
1. 0 to 30 psi.
 2. 0 to 100 psi.
 3. 0 to 160 psi.
- C. Scale Range for Heating, Hot-Water Piping:
1. 0 to 30 psi.
 2. 0 to 100 psi.
 3. 0 to 160 psi.
 4. 0 to 600 psi.
- D. Scale Range for Steam and Steam Condensate Piping:
1. Vacuum Systems:
 - a. 30-in. Hg to 15 psi.
 2. Low Pressure Steam Piping:
 - a. 0 to 30 psi.
 3. Medium Pressure Steam Piping:
 - a. 0 to 100 psi.
 4. High Pressure Steam Piping:
 - a. 0 to 160 psi.
 - b. 0 to 200 psi.
 - c. 0 to 300 psi.

PART 4 - SUPPLEMENTAL REQUIREMENTS:

4.1 TEMPERATURE GAUGE INSTALLATION

- A. All gauges to be rated for fluid applications with expected operating pressure to fall in the middle of the pressure range.
- B. Thermometers shall be located in the following locations (minimum):
 - 1. Supply and return of heating hot water boilers.
 - 2. Discharge from domestic water heaters and downstream of master mixing valve supply to building.
 - 3. Supply and Return to hydronic heating boilers.
 - 4. Supply and return to chillers and cooling towers (condensers).
 - 5. Supply and return to heat exchangers, both domestic and hydronic.
 - 6. Discharge off sterilizer drains.
 - 7. Supply and return chilled/heating water serving air handling unit cooling/heating/preheat coil sections.
 - 8. Discharge line of chilled/heating water pumps.

4.2 PRESSURE GAUGE INSTALLATION

- A. All gauges to be rated for fluid applications with expected operating pressure to fall in the middle of the pressure range
- B. Gauges shall include isolation ball or gate valve (steam), schedule 80 nipples, fittings and pipe. Provide tee fitting between isolation valve and gauge.
- C. Pressure gauges shall be located in the following locations (minimum):
 - 1. Suction and discharge of pumps.
 - 2. Discharge of steam condensate pumps.
 - 3. At pressure reducing fill valves both upstream and downstream.
 - 4. All PRV (pressure regulating valve) stations both upstream and downstream of station.
 - 5. All expansion tanks.
 - 6. All inlet and discharge of Air and Dirt Separators.
 - 7. Central station AHU coil supply and return piping.
 - 8. Upstream and downstream of main building backflow devices, i.e. fire system double check and domestic water RPBP (RPZ).

4.3 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Mercury type thermometers are not permitted.

- C. All gauges to be rated for fluid applications with expected operating pressure to fall in the middle of the pressure range. Select range for various utilities above.

END OF SECTION 230519

KSU DESIGNERS NOTES:

1. Dial thermometers minimum 4½" diameter will be acceptable in certain fluid applications. Consult with OUA.

SECTION 230523 – GENERAL DUTY VALVES AND STRAINERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Ball Valves
- 2. Butterfly Valves
- 3. Check (Silent Type)
- 4. Check (Swing Type)
- 5. Gate Valves
- 6. Globe Valves
- 7. Strainers
- 8. Chainwheels.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set butterfly valves closed or slightly open.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B16.1 for flanges on iron valves.
 2. ASME B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 4. ASME B31.1 for power piping valves.
 5. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Actuator Types:
1. Gear Actuator: For valves NPS 8 and larger.
 2. Handlever: For valves NPS 6 and smaller.
 3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.
- G. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.2 BALL VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ball Valves 1" and smaller:

- a. Conbraco (Apollo).
- b. Crane.
- c. Grinnell.
- d. Jenkins.
- e. Nibco.
- f. Stockham.
- g. Watts.
- h. Milwaukee.
- i. Milwaukee Butterball.
- j. Hammond.

2. Ball Valves – 1-1/4" and larger

- a. Conbraco (Apollo).
- b. Grinnell.
- c. Nibco.
- d. Stockham.
- e. Watts.
- f. Milwaukee.
- g. Milwaukee Butterball.

B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim (3" and Smaller):

1. Description:

- a. Standard: MSS SP-110.
- b. Body Design: Two piece.
- c. Body Material: Forged brass or bronze.
- d. Seats: PTFE or RPTFE.
- e. Stem: Brass or bronze, blowout proof pressure retaining.
- f. Ball: Chrome-plated brass.
- g. Port: Full.
- h. Ends: Threaded or Soldered.
- i. Ends: Press with Buna-N or EPDM O-Ring Seal.
- j. Maximum Rating:
 - 1) CWP: 600 psig.
 - 2) SWP: 150 psig.
 - 3) Similar to Nibco model T-585-70-SV.

C. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim (2-1/2" and Smaller):

1. Description:

- a. Standard: MSS SP-110.
- b. Body Design: Two piece.
- c. Body Material: Forged brass or bronze.
- d. Seats: PTFE or RPTFE.
- e. Stem: Stainless steel, blowout proof pressure retaining.

- f. Ball: Stainless steel, vented.
- g. Port: Full.
- h. Ends: Threaded or Soldered.
- i. Ends: Press with Buna-N or EPDM O-Ring Seal.
- j. Maximum Rating:
 - 1) CWP: 600 psig.
 - 2) SWP: 150 psig.
- k. Similar to Nibco model T-580-70-66.

D. Steel Ball Valves, Three Piece with Full Port and Stainless-Steel Trim (2" and Smaller)

1. Description:

- a. Standard: MSS SP-72.
- b. Body Design: Three piece.
- c. Body Material: Carbon steel, ASTM A 216, Type WCB.
- d. Seats: RPTFE.
- e. Stem: Stainless steel, blowout proof.
- f. Ball: Stainless steel, vented.
- g. Port: Conventional.
- h. Ends: Threaded.
- i. SWP Rating: 250 psig.
- j. Similar to Nibco model TM-590-CS-R-66-FS-LL.

E. Steel Ball Valves with Full Port and Stainless-Steel Trim (2-1/2" and Larger)

1. Description:

- a. Standard: MSS SP-72.
- b. Body Design: One piece.
- c. Body Material: Carbon steel, ASTM A 216, Type WCB.
- d. Seats: RPTFE.
- e. Stem: Stainless steel, blowout proof.
- f. Packing Gland and Stop Plate: Stainless steel.
- g. Ball: Stainless steel, vented.
- h. Port: Conventional.
- i. Ends: Flanged.
- j. Rating: Class 150.
 - 1) CWP Rating: 285 psig.
 - 2) Similar to Nibco model F-510-CS-R-66-FS.
- k. Rating: Class 300.
 - 1) CWP Rating: 720 psig.
 - 2) Similar to Nibco model F-530-CS-R-66-FS.

2.3 BUTTERFLY VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Standard Duty Butterfly Valves:

- a. Crane.
- b. Dezurik.
- c. Grinnell.
- d. Milwaukee.
- e. Nibco.
- f. Victaulic.

2. High Performance Butterfly Valves:

- a. Centerline.
- b. Flowseal.
- c. Quadax.
- d. Saunders.
- e. Vanessa.
- f. Zwick.

B. Iron, Single-Flange Butterfly Valves (2-1/2" and Larger):

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- c. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- d. Seat: EPDM.
- e. Stem: One- or two-piece stainless steel.
- f. Disc: Aluminum bronze, coated ductile iron, or stainless steel.
- g. Ends: Single flange
- h. Ends: Grooved end.
- i. Maximum Rating:
 - 1) NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - 2) NPS 14 to NPS 24, CWP Rating: 150 psig.
 - 3) Similar to Nibco LD Series.

C. Iron, Grooved-End Butterfly Valves, 300 CWP (2-1/2" and Larger):

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. Body Material: Coated, ductile iron.
- c. Stem: Two-piece stainless steel.
- d. Disc: Coated, ductile iron.
- e. Seal: EPDM.
- f. Maximum Rating:
 - 1) NPS 2-1/2 to NPS 8, CWP Rating: 300 psig.
 - 2) NPS 10 to NPS 24, CWP Rating: 200 psig.
 - 3) Similar to model Victaulic model Vic-300 Master Seal.

D. Double-Flange, High-Performance Butterfly Valves (3" and Larger):

1. Description:

- a. Standard: API 607 Rev. 4 and API 6D.
- b. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange. Triple or Quad offset disc movement relative to the shaft. Include totally enclosed worm gear operator.
- c. Body Material: Carbon steel ASTM A216 Grade WCB.
- d. Shaft: ASTM A564 type 630, one piece construction
- e. Shaft Seal: Graphite with four stud packing follower.
- f. Bearings: Hardened with bearing seal retained in body.
- g. Seat: Resilient, non-flexing laminate metal seal composite of stainless steel and graphite retained such that centering movement is permitted.
- h. Stem: Stainless steel; offset from seat plane.
- i. Disc: Stainless steel ASTM a351 Grade CF8M 316, or manufacturer's standard for given service.
- j. Service: Bidirectional.
- k. ANSI Rating: Class 150.
 - 1) CWP Rating: 290 psig at 100 deg F.
 - 2) Similar to Quadax Four Offset Butterfly Valves.
- l. ANSI Rating: Class 300.
 - 1) CWP Rating: 750 psig at 100 deg F.
 - 2) Similar to Quadax Four Offset Butterfly Valves.

2.4 CHECK (SWING TYPE) VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Crane.
 - 2. Grinnell.
 - 3. Hammond.
 - 4. Jenkins.
 - 5. Nibco.
 - 6. Stockham.
- B. Bronze Y-Pattern Swing Check Valves with Bronze Disc (2" and smaller):
 - 1. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. Body Design: Horizontal flow.
 - c. Body Material: ASTM B 62, bronze.
 - d. Disc: Bronze or Brass.
 - e. Ends: Threaded.
 - f. Rating: Class 150.
 - 1) CWP Rating: 300 psig.
 - 2) SWP Rating: 150 psig.
 - 3) Similar to Nibco model T-433-B.
 - g. Rating: Class 200.
 - 1) CWP Rating: 400 psig.
 - 2) SWP Rating: 200 psig.
 - 3) Similar to Nibco model T-453-B

- h. Rating: Class 300.
 - 1) CWP Rating: 600 psig.
 - 2) SWP Rating: 300 psig.
 - 3) Similar to Nibco model T-473-B.

C. Iron Swing Check Valves with Metal Seats (2-1/2" and larger):

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. Body Design: Clear or full waterway.
- c. Body Material: ASTM A 126, gray iron with bolted bonnet.
- d. Trim: Bronze.
- e. Disc: Bronze or Cast Iron (8" and larger)
- f. Gasket: Asbestos free.
- g. Ends: Flanged.
- h. Rating: Class 125
 - 1) NPS 2-1/2 to NPS 12, 200 psig CWP, 125 SWP.
 - 2) NPS 14 to NPS 24, 150 psig CWP, 100 SWP.
 - 3) Similar to Nibco model F-918-B.
- i. Rating: Class 250
 - 1) NPS 2-1/2 to NPS 8, 500 CWP, 250 SWP.
 - 2) NPS 10 to NPS 24, 300 CWP.
 - 3) Similar to Nibco model F-968-B.

D. Iron, Grooved-End Swing Check Valves (2-1/2" and larger):

1. Description:

- a. Body Material: ASTM A 536, ductile iron.
- b. Seal: EPDM (-30 to 230 Degrees F).
- c. Disc: Spring operated, ductile iron or stainless steel.
- d. Ends: Grooved.
- e. CWP Rating: 300 psig.
- f. Similar to Victaulic Series 716 Vic-Check.

2.5 CHECK (SILENT TYPE) VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Mueller Steam Specialty.
- 2. Williams-Hager.
- 3. Metra-flex.

B. Globe, Center-Guided Check Valves with Metal Seat (2" and smaller):

1. Description:

- a. Standard: MSS SP-125.

- b. Body Material: Bronze, or ASTM A 126, gray iron.
- c. Style: Globe, spring loaded.
- d. Seat: Bronze or Brass.
- e. Disc: Brass.
- f. Ends: Threaded.
- g. Rating: Class 125.
 - 1) CWP Rating: 200 psig.
 - 2) Similar to Mueller Steam Specialty model 303AP.

C. Iron, Globe, Center-Guided Check Valves with Metal Seat (2-1/2" and larger):

1. Description:

- a. Standard: MSS SP-125.
- b. Body Material: ASTM A 126, gray iron.
- c. Style: Globe, spring loaded.
- d. Ends: Flanged.
- e. Seat: Bronze or stainless steel.
- f. Rating: Class 125.
 - 1) NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - 2) NPS 14 to NPS 24, CWP Rating: 150 psig.
 - 3) Similar to Mueller Steam Specialty model 105 MAP.
- g. Rating: Class 250.
 - 1) NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - 2) NPS 14 to NPS 24, CWP Rating: 300 psig.
 - 3) Similar to Mueller Steam Specialty model 107 MAP.

2.6 GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Gate valves 2" and smaller:

- a. Crane.
- b. Grinnell.
- c. Hammond.
- d. Jenkins.
- e. Lunkheimer.
- f. Milwaukee.
- g. Nibco.
- h. Powell.
- i. Stockham.

2. Gate valves 2-1/2" and larger:

- a. Crane.
- b. Grinnell.
- c. Hammond.
- d. Jenkins.

- e. Lunkenheimer.
- f. Milwaukee.
- g. Nibco.
- h. Powell.
- i. Stockham.

B. Bronze Gate Valves, RS (Sizes 2" and Smaller):

1. Description:

- a. Standard: MSS SP-80, Type 2.
- b. Body Material: ASTM B 61 or 62, bronze with integral seat.
- c. Stem: Bronze.
- d. Disc: Solid wedge; bronze.
- e. Port: Full.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron, bronze, cast iron, or aluminum.
- h. Ends: Threaded.
- i. Rating: Class 125.
 - 1) Screw in bonnet.
 - 2) CWP Rating: 200 psig.
 - 3) SWP Rating: 125 psig.
 - 4) Similar to Nibco model T-111.
- j. Rating: Class 150.
 - 1) Screw in bonnet.
 - 2) CWP Rating: 300 psig.
 - 3) SWP Rating: 150 psig.
 - 4) Similar to Nibco model T-134.
- k. Rating: Class 300.
 - 1) Union bonnet.
 - 2) Seats: Stainless steel.
 - 3) CWP Rating: 600 psig.
 - 4) SWP Rating: 300 psig.
 - 5) Similar to Nibco model T-174-SS.

C. Iron Gate Valves, OS&Y (Sizes 2-1/2" and Larger):

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. Body Material: ASTM A 126, gray iron with bolted bonnet.
- c. Trim: Bronze.
- d. Disc: Solid wedge, bronze or cast iron (NPS 4 and larger).
- e. Packing and Gasket: Asbestos free.
- f. Ends: Flanged.
- g. Rating: Class 125.
 - 1) NPS 2-1/2 to NPS 12, CWP Rating: 200 psig, SWP Rating: 125 psig.
 - 2) NPS 14 to NPS 24, CWP Rating: 150 psig, SWP Rating: 100 psig.
 - 3) Similar to Nibco model F-617-0
- h. Rating: Class 250.
 - 1) NPS 2-1/2 to NPS 12, CWP Rating: 500 psig, SWP Rating: 250 psig.

- 2) NPS 14 to NPS 24, CWP Rating: 300 psig.
- 3) Similar to Nibco model F-667-0.

2.7 GLOBE VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane.
2. Grinnell.
3. Hammond.
4. Jenkins.
5. Nibco.
6. Stockham.

- B. Bronze Globe Valves, RS (2" and Smaller):

1. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - c. Stem: Bronze.
 - d. Packing: Asbestos free.
 - e. Handwheel: Malleable iron.
 - f. Ends: Threaded.
 - g. Rating: Class 150.
 - 1) Disc: Bronze, PTFE, or Stainless Steel.
 - 2) CWP Rating: 300 psig.
 - 3) SWP Rating: 150 psig.
 - 4) Similar to Nibco model T-235-Y.
 - h. Rating: Class 200.
 - 1) Disc: Stainless Steel.
 - 2) CWP Rating: 400 psig.
 - 3) SWP Rating: 200 psig.
 - 4) Similar to Nibco model T-256-AP.
 - i. Rating: Class 300.
 - 1) Disc: Stainless Steel.
 - 2) CWP Rating: 600 psig.
 - 3) SWP Rating: 300 psig.
 - 4) Similar to Nibco model T-276-AP.

- C. Iron Globe Valves, OS&Y (2-1/2" and Larger):

1. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - c. Packing and Gasket: Asbestos free.
 - d. Operator: Handwheel (Malleable Iron or Cast Iron) or chainwheel.
 - e. Ends: Flanged.

- f. Rating: Class 125.
 - 1) Trim: Bronze or Cast Iron.
 - 2) Disc: Bronze, Brass, or Cast Iron (4" and larger).
 - 3) CWP Rating: 200 psig.
 - 4) SWP Rating: 125 psig.
 - 5) Similar to Nibco model F-718-B.
- g. Rating: Class 250.
 - 1) Disc: Bronze (2-1/2" to 3") or Cast Iron.
 - 2) Trim: Bronze.
 - 3) CWP Rating: 500 psig.
 - 4) SWP Rating: 250 psig.
 - 5) Similar to Nibco model F-768-B.

2.8 STRAINERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong.
 - 2. Crane.
 - 3. Sarco.
 - 4. MEPCO.
 - 5. Metraflex.
 - 6. Mueller Steam Specialty.
- B. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B or ASTM A48, Class 30 cast iron, with bolted cover and bottom drain connection.
 - 2. Strainer Screen:
 - a. Stainless-steel, 20-mesh strainer (NPS 2 and under for hydronic systems)
 - b. Stainless-steel, 30-mesh strainer (NPS 2 and under for steam).
 - c. Stainless-steel, 0.062" perforated strainer (NPS 2-1/2 – 4 for hydronic systems)
 - d. Stainless-steel, 0.045" perforated strainer (NPS 2-1/2 – 10 for hydronic systems)
 - e. Stainless-steel, 0.125" perforated strainer (NPS 12 and larger for hydronic systems)
 - 3. Tapped blowoff plug. Drilled with minimum NPS 1-1/4 for strainers NPS 2-1/2 and larger.
 - 4. End Connections: Threaded ends for strainers NPS 2 and smaller
 - 5. End Connections: Flanged ends for strainers NPS 2-1/2 and larger.
 - 6. End Connections: Grooved NPS 2 and larger.
 - 7. Rating: Class 125 similar to Mueller Steam Specialty model 758.
 - 8. Rating: Class 250 similar to Mueller Steam Specialty model 752.

2.9 CHAINWHEELS

Edit options below and coordinate with Owner.

Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

1. Sprocket Rim with Chain Guides: [Ductile iron] [Ductile or cast iron] [Cast iron] [Aluminum] [Bronze], of type and size required for valve. [Include zinc or epoxy coating.]
2. Chain: [Hot-dip, galvanized steel] [Brass] [Stainless steel], of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Valves shall be provided in suitable locations at each item of equipment, branch circuit, riser, or section of piping as indicated or required for proper and safe operation of the system and to facilitate maintenance and/or removal of all equipment and apparatus. On horizontal pipe runs, install all valve stems vertically up where possible and in no case shall the stems be turned more than 90 degrees from the vertically up position.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Install valves in position to allow full stem movement.
- D. Install check valves for proper direction of flow and as follows:
 1. Swing Check Valves: In horizontal position with hinge pin level.
 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
- E. Steam control valves shall be installed with actuator/shaft one bolt pattern off top dead center to minimize controller heat damage.

- F. Install strainers upstream of steam control valves with the wye in the horizontal plane. All other locations, wye pattern to be installed in the vertical plane.
- G. Install blowdown valves on all strainers 1-1/2" and larger. Blowdown valves to be ball valves for hydronic piping and gate valves for steam and steam condensate piping. Strainer blowdown valves to be sized to match blowdown connection size, but not less than 3/4". Terminate blowdown with hose thread connection and cap or plug.

Edit options below and coordinate with Owner.

- H. Install chainwheels on operators for manual valves [NPS 2-1/2] and larger and more than [84 inches] <Insert dimension> above floor. Extend chains to [60 inches] <Insert dimension> above finished floor.
- I. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. Install valves in compliance with manufacturer's installation instructions.
- B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end or press style options are indicated in valve schedules.
 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.
 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
 6. For Steel Piping, NPS 5 and Larger: Flanged ends.
 7. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

Retain only items and systems relevant to project.

3.4 HYDRONIC SYSTEM VALVE SCHEDULE (SYSTEMS LESS THAN 150 PSIG)

A. Ball Valves

1. Pipe NPS 3 and Smaller: Brass or bronze ball valves, two piece, with brass or bronze trim, full port.
 - a. Valves may be provided with solder-joint ends or press style instead of threaded ends.

B. Butterfly Valves

1. Pipe NPS 2-1/2 and Larger:

- a. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze, Ductile-iron, or Stainless-steel disc, 200 CWP, and EPDM seat.
- b. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze, Ductile-iron, or Stainless-steel disc, 150 CWP, and EPDM seat.
- c. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 8: 300 CWP.
- d. Iron, Grooved-End Butterfly Valves, NPS 10 to NPS 24: 200 CWP.

C. Check (Swing Type) Valves

1. Pipe NPS 2 and Smaller:

- a. Bronze Valves: Valves may be provided with solder-joint ends or press style instead of threaded ends.
- b. Bronze swing check valves with bronze disc, Class 150.

2. Pipe NPS 2-1/2 and Larger:

- a. NPS 2-1/2 to NPS 12: Iron swing check valves with lever closure control, Class 125.
- b. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.

D. Check (Silent Type) Valves

1. Pipe NPS 2 and smaller

- a. Bronze or Iron, globe, center-guided check valves metal seat, class 125.

2. Pipe NPS 2-1/2 and Larger:

- a. Iron, globe, center-guided check valves metal seat, Class 125.

E. Globe Valves

1. Pipe NPS 2 and Smaller: Bronze angle or globe valves, Class 125, Bronze, PTFE or Stainless Steel disc, with soldered or threaded ends.
2. Pipe NPS 2-1/2 and Larger: Iron globe valves, Class 125, with flanged ends.

F. Strainers

1. Pipe NPS 2 and Smaller: Y-pattern strainers, Class 125 with soldered or threaded ends.
2. Pipe NPS 2-1/2 and Larger: Y-pattern strainers, Class 125, with flanged ends.

Edit out section below when not necessary.

3.5 HIGH PRESSURE HYDRONIC SYSTEM VALVE SCHEDULE (SYSTEMS GREATER THAN 150 PSIG, LESS THAN 300 PSIG)

A. Ball Valves

1. Pipe NPS 3 and Smaller: Brass or bronze ball valves, two piece, with brass or bronze trim, full port, threaded or press connection-joint ends, 600 CWP.

- a. Valves may be provided with solder-joint ends instead of threaded ends.

B. Butterfly Valves

1. Pipe NPS 2-1/2 and Larger:

- a. High Performance, NPS 2-1/2 and Larger: Carbon steel disc, Class 300.

C. Check (Swing Type) Valves

1. Pipe NPS 2 and Smaller:

- a. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - b. Bronze swing check valves with bronze disc, Class 200 (400 CWP).

2. Pipe NPS 2-1/2 and Larger:

- a. NPS 2-1/2 to NPS 12: Iron swing check valves with lever closure control, Class 250.

D. Check (Silent Type) Valves

1. Pipe NPS 2 and Larger:

- a. Iron, globe, center-guided check valves metal seat, Class 250.

E. Globe Valves

1. Pipe NPS 2 and Smaller: Bronze angle or globe valves, Class 200 (400 CWP), Stainless Steel disc, with soldered or threaded ends.
2. Pipe NPS 2-1/2 and Larger: Iron globe valves, Class 250, with flanged ends.

F. Strainers

1. Pipe NPS 2 and Smaller: Y-pattern strainers, Class 250 with soldered or threaded ends.
2. Pipe NPS 2-1/2 and Larger: Y-pattern strainers, Class 250, with flanged ends.

3.6 LOW AND MEDIUM-PRESSURE STEAM / CONDESNSATE / PUMPED CONDENSATE VALVE SCHEDULE (65 PSIG OR LESS)

A. Ball Valves

1. Pipe NPS 2 and Smaller: Brass or bronze ball valves, two piece, with stainless-steel trim, and full port.
2. Pipe NPS 2-1/2 and Larger: Steel ball valves, Class 150.

B. Butterfly Valves

1. Pipe NPS 2-1/2 and Larger: High-performance butterfly valves, double flange, Class 150.

C. Check (Swing Type)

1. Pipe NPS 2 and Smaller:
 - a. Bronze swing check valves with bronze disc, Class 150.
2. Pipe NPS 2-1/2 and Larger:
 - a. Iron swing check valves with metal seats: Class 125.
 - b. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and closure control, Class 125.

D. Gate Valves

1. Pipe NPS 2 and Smaller: Bronze gate valves, RS, Class 150.
2. Pipe NPS 2-1/2 and Larger: Iron gate valves, OS&Y, Class 125.

E. Globe Valves

1. Pipe NPS 2 and Smaller: Bronze angle or globe valves, Class 150, bronze or PTFE disc, and soldered or threaded ends.
2. Pipe NPS 2-1/2 and Larger: Iron globe valves, Class 125, with flanged ends.

F. Strainers

1. Pipe NPS 2 and Smaller: Y-pattern strainers, Class 125 with threaded ends.
2. Pipe NPS 2-1/2 and Larger: Y-pattern strainers, Class 125, with flanged ends.

3.7 HIGH-PRESSURE STEAM / CONDENSATE VALVE SCHEDULE (GREATER THAN 65 PSIG)**A. Ball Valves**

1. Pipe NPS 2 and Smaller: Steel ball valves, three piece with stainless-steel trim, and conventional port, 250 SWP.
2. Pipe NPS 2-1/2 and Larger: Steel ball valves, Class 300.

B. Butterfly Valves

1. Pipe NPS 2-1/2 and Larger: High-performance butterfly valves, double flange, Class 300.

C. Check Valves

1. Pipe NPS 2 and Smaller: Bronze swing check valves with bronze disc, Class 300.
2. Pipe NPS 2-1/2 and Larger: Iron swing check valves with lever and closure control, Class 250.

D. Gate Valves

1. Pipe NPS 2 and Smaller: Bronze gate valves, RS, Class 300.
2. Pipe NPS 2-1/2 and Larger: Iron gate valves, OS&Y, Class 250.

E. Globe Valves

1. Pipe NPS 2 and Smaller: Bronze angle or globe valves, Class 300, with bronze disc and threaded ends.
2. Pipe Sizes NPS 2-1/2 and Larger: Iron globe valves, Class 250 with flanged ends.

F. Strainers

1. Pipe NPS 2 and Smaller: Y-pattern strainers, Class 250 with threaded ends.
2. Pipe NPS 2-1/2 and Larger: Y-pattern strainers, Class 250 with flanged ends.

3.8 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Kent State Requirements:
1. Submittal Data: Information on each valve, including parts list and supplier contact name and phone number, shall be submitted to the A/E for review. This information shall be included in the operational maintenance manuals.
 2. Valves shall be by one manufacturer whenever possible.
 3. Drain valves and manual air vents shall be comprised of a full port ball valve with a capped hose end connection. The cap shall be attached to the valve with a chain.
 4. Hydronic systems (2" and smaller) shall utilize valves as indicated with soldered connections where used for zone isolation, or threaded connections when used in conjunction with a union for equipment isolation.
 5. Hydronic systems shall utilize full port quarter-turn ball valves for isolation up to and including 2-1/2". Butterfly valves to be used for 3" and above.
 6. Valve bonnet must be repairable flanged or union style. Steam, condensate and high temperature hot water (210°F. and higher), shall utilize rising stem.
 7. Installation of multipurpose valves shall also be supplied with manual isolation valves so check valve in multipurpose valve can be worked on and maintained without draining system.
 8. No valves are to be installed above inaccessible ceilings or within chases or shafts.

9. Grooved piping systems and valves are not allowed to be installed above inaccessible ceilings or within chases or shafts.
10. Quarter turn valves shall not be used in steam and condensate piping systems.
11. High Performance Butterfly valves to be used for isolation in tunnels off main high and medium pressure steam mains. These must include warmup bypasses. Double valve shutoffs are required on high pressure steam systems. Steam system downtime must be coordinated with the University as there is limited scheduled downtimes available that affect the whole system.

END OF SECTION 230523

KSU DESIGNERS NOTES:

1. Grooved piping systems and valves are not allowed to be installed above inaccessible ceilings or within chases or shafts.
2. Grooved piping and valves are not to be installed on tower water systems without prior approval by the KSU Project Manager due to past issues on campus related to water treatment issues.
3. Miscellaneous Mechanical Room Replacements: Access to mechanical rooms shall be analyzed for future replacement of large equipment. Manual valves larger than 2" inches diameter and above 7'-0" in height to have chain wheel operators in mechanical equipment type spaces. **REVIEW THIS ON A PROJECT BY PROJECT BASIS.** The plans shall clearly indicate potential restrictions/service areas and detail the areas appropriately. Coordinate all systems to provide maximum head room with no items below 7'-0" A.F.F. Chain wheels' installation shall be coordinated and approved for use by OUA.
4. The use of gate valves within any hydronic, plumbing system shall be reviewed with OUA prior to including in specifications. If gate valves are used for steam applications, they shall be specified to have rising stem. This applies to all steam and steam condensate systems. Avoid Non-rising stem valves and only allowed with written approval by OUA mechanical engineers.
5. Drain valves and manual air vents shall be comprised of a full port ball valve with a capped hose end connection. The cap shall be attached to the valve with a chain.
6. Auto air vents (only in unfinished or mechanical spaces) shall be Hoffman 79 or approved equivalent. All shall be piped to nearest floor drain where possible. All air vents above finished spaces shall be a ¾" ball drain valve with hose thread connection, cap and chain.
7. Mechanical and pressure joint systems are acceptable on applicable piping services except for steam and condensate.
8. Steam (15 psig or less) (low pressure) (150 class) 16 psig to 65 psig 150 class.
9. Steam Condensate (gravity, low pressure) (15 psig or less) (150 class) Rising stem on gate valves.
10. Steam Condensate (gravity, high pressure) (300 class) Rising stem on gate valves.
11. Steam (15 to 125 psig) ½" to 2½" dia. 300 class; 3" to 18", 150 class, 300 class at power plant or connected to plant's main header. Rising stem on gate valves.
12. Feed Water (Class 300)

13. All drain valves shall be ball valves with $\frac{3}{4}$ " hose adaptor connection. Valve shall be provided with chain on end with solid gasketed end cap
14. Valves shall be provided in suitable locations at each item of equipment, branch circuit, riser or section of piping as indicated or required for proper and safe operation of the system and to facilitate maintenance and/or removal of all equipment and apparatus. Design shall also incorporate interstitial isolation valves for partial system isolation. Number of isolation valves shall be reviewed with OUA engineers.
15. Hydronic heating and cooling system ($2\frac{1}{2}$ " and larger): Valves shall have flanged connections.
16. Steam and steam condensate (2" and smaller): Valves shall have threaded connections.
17. Steam and steam condensate ($2\frac{1}{2}$ " and larger): Valves shall have flanged connections.
18. Mechanical and pressure joint systems are acceptable on applicable piping services except for steam and condensate.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.
8. Roof equipment supports.

B. Related Requirements:

Retain only relevant sections below.

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. [Section 230548 "Vibration and Seismic Controls for HVAC"] [Section 230548.13 "Vibration Controls for HVAC"] for vibration isolation devices.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support. For equipment curbs supply manufacturer's certified load bearing data.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support, indicating dimensions, weights, required clearances, and methods of assembly of components.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.
- C. Codes and Standards:
 - 1. Code Compliance: Unless requirements are exceeded herein, comply with applicable codes pertaining to product materials and installation of supports and anchors. For Ohio projects, follow the State Architect's "Handbook of Instruction" and Ohio Building Code for maximum hanger spacing requirements.
 - 2. Comply with NFPA 13 for hangers and supports used as components of fire protection systems. Include listing and labeling by UL and FM.

PART 2 - PRODUCTS

2.1 MANUFACTURERS OF HANGERS AND SUPPORTS:

- A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - 1. B-Line Systems, Inc.
 - 2. Globe Hanger
 - 3. ITT Grinnell Corp.
 - 4. Michigan Hanger
 - 5. Modern Hanger
 - 6. nVent Caddy
 - 7. PHD Manufacturing, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

Retain below if seismic restraints are required.

- 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.3 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper, factory-fabricated components or nylon. Plated copper is not acceptable.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel or stainless steel.

2.4 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
- B. Cushion Clamps: UL Classified 2043 (25/50), Molded with high strength Thermoplastic Elastomer (TPE). Temperature rating: -65°F to 275°F. Clamps to be by Hydra-Zorb.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psi or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with 100-psi ASTM C 552, Type II cellular glass with 100-psi minimum compressive strength.
- C. Insulation-Pipe Supports for Cold or Hot Piping: Where insulated piping is supported from unistrut or other similar systems, crush resistant insulation clamps similar to ZSI Cush-A-Therm, K-Flex® 360 Insulated Pipe Support, and Klo-Shure insulation couplings will be acceptable.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Indoor Applications: Zinc-coated or stainless-steel.
 - 2. Outdoor Applications: Stainless steel.

2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
 - 1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Hardware: Galvanized steel or polycarbonate.
 - 4. Accessories: Protection pads.
- C. Low-Profile, Single Base, Single-Pipe Stand:

Engineer to provide detail of assembly including pipe support types and heights.

- 1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Vertical Members: Two, galvanized (indoor applications) or stainless-steel (outdoor applications), continuous-thread 1/2-inch rods.
 - 4. Horizontal Member: Adjustable horizontal, galvanized (indoor applications) or stainless-steel (outdoor applications) pipe support channels.
 - 5. Pipe Supports: Roller, Strut clamps, Clevis hanger, or Swivel hanger as detailed on drawings.
 - 6. Hardware: Galvanized (indoor applications) or Stainless steel (outdoor applications).
 - 7. Accessories: Protection pads.
 - 8. Height: See details on drawings.
- D. High-Profile, Single Base, Single-Pipe Stand:

Engineer to provide detail of assembly including pipe support types and heights.

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.
3. Vertical Members: Two, galvanized (indoor applications) or stainless-steel (outdoor applications), continuous-thread 1/2-inch rods.
4. Horizontal Member: One, adjustable height, galvanized (indoor applications) or stainless-steel (outdoor applications) pipe support slotted channel or plate.
5. Pipe Supports: Roller or Clevis hanger as detailed on drawings.
6. Hardware: Galvanized (indoor applications) or stainless steel (outdoor applications).
7. Accessories: Protection pads, 1/2-inch continuous-thread galvanized-steel rod (indoor applications) , 1/2-inch continuous-thread stainless-steel rod (outdoor applications).
8. Height: See details on drawings.

E. High-Profile, Multiple-Pipe Stand:**Engineer to provide detail of assembly including pipe support types and heights.**

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; vulcanized rubber or molded polypropylene.
3. Vertical Members: Two or more, galvanized (indoor applications) or stainless-steel (outdoor applications) channels.
4. Horizontal Members: One or more, adjustable height, galvanized (indoor applications) stainless-steel (outdoor applications) pipe support.
5. Pipe Supports: Roller, Strut clamps, Clevis hanger, Swivel hanger as detailed on drawings.
6. Hardware: Galvanized (indoor applications) or Stainless steel (outdoor applications).
7. Accessories: Protection pads, 1/2-inch continuous-thread rod.
8. Height: See details on drawings.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.**2.8 EQUIPMENT SUPPORTS**

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 ROOF EQUIPMENT SUPPORTS**SPECIFIER NOTE: COORDINATE TYPE OF ROOF EQUIPMENT SUPPORTS USED WITH ROOF CONSTRUCTION. VERIFY WHO FURNISHES AND WHO INSTALLS ROOF EQUIPMENT SUPPORTS WITH ARCHITECT.**

- A. Refer to the drawings, schedules and applicable specification sections for roof equipment supports indicated to be furnished by the unit manufacturer.

SPECIFIER NOTE: DELETE ABOVE, BELOW OR BOTH (IF ROOF EQUIPMENT SUPPORTS ARE SPECIFIED IN DIVISION 7) TO SUIT PROJECT REQUIREMENTS.

B. Fabricated Roof Equipment Supports:

1. General: Construct roof equipment supports using minimum 18-ga galvanized steel with fully mitered and welded corners, 3" cant, internal bulkhead reinforcing, integral base plates, pressure treated wood nailer, and 18-ga galvanized steel counterflashing.
2. Configuration: Construct of sizes as indicated, compensate for slope in roof so top of support is dead level.
3. Pipe Boots: Provide boots for piping, power conduit and control conduit as required by pipe curb manufacturer. Boot to be expandable, designed to accommodate the pipe or conduit size utilized, and capable of maintaining a weather-tight seal even with minor vibration in piping.
4. Manufacturer: Subject to compliance with requirements, provide roof equipment supports of one of the following:
 - a. Custom Curb
 - b. Pate Co.
 - c. Roof Products and Systems (RPS)
 - d. Thycurb Division; Thybar Corp.

2.10 MATERIALS

- A. Aluminum: ASTM B 221.
- B. Carbon Steel: ASTM A 1011/A 1011M.
- C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; galvanized.
- D. Stainless Steel: ASTM A 240/A 240M.
- E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- F. Metal Framing: NEMA STD ML 1.
- G. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards. Material coatings for interior use shall be electro-plated zinc (ASTM B633), or mill galvanized (ASTM A525 G90). For exterior use, materials shall be hot-dip galvanized after fabrication (ASTM A386).
- H. Bolts and Nuts: ASME B18.10 or ASTM A183, steel, hex-head, track bolts and nuts. Use galvanized or stainless steel for use in moist environments.
- I. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Non-staining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

3.2 INSPECTION:

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.3 PREPARATION:

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washer and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire protection piping independently of other piping.
- D. Prevent electrolysis in support of copper tubing by use of copper or nylon clamps and supports which are copper or stainless steel, or by other recognized industry methods. Copper plated clamps in direct contact with copper piping is not acceptable.
- E. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- F. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- G. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- H. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- I. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- J. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
- Retain below if section 077200 is included in specifications.**
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- Q. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

3.5 EQUIPMENT SUPPORTS

- A. Provide painted structural steel stands to support equipment from structure overhead or to support equipment above floor.
- B. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.
- C. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- D. Provide lateral bracing, to prevent swaying, for equipment supports.

3.6 ROOF EQUIPMENT SUPPORTS:

Select one of the two paragraphs below. First paragraph is for projects where equipment supports are installed by division 07 work. Second paragraph is when provided and installed by this contractor.

- A. Furnish roof equipment supports to Contractor for installation as part of work of Division 7; not work of this section.
- B. Install roof equipment supports in compliance with manufacturer's instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive accessory units, vapor barriers, roof insulation, roofing and flashing as required to ensure that each element of the work performs properly and that combined elements are waterproof and weathertight. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures. Meet all requirements necessary to maintain the roofing manufacturer's warranty as applicable.

3.7 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.8 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.9 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 230501 Basic Materials and Methods for HVAC for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.10 HANGER AND SUPPORT SCHEDULE

- A. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- C. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- D. Use stainless-steel pipe hangers and stainless-steel attachments for outdoor and hostile environment applications.
- E. Use copper or nylon pipe clamps and copper or stainless-steel attachments for copper piping and tubing.
- F. Use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with

MSS SP-69 and manufacturer's published product information. Use only one type of one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Copper-plated clamps are not acceptable for copper-piping systems. Clamps in direct contact of copper piping to be copper or nylon. Provide felt lined hangers or clamps for uninsulated refrigerant piping to eliminate transmission of sound and vibration. Perforated strap hangers shall not be used in any work. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 4. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 5. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 8. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
- I. Vertical-Piping Clamps: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with MSS SSP-58, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Copper-plated clamps are not acceptable for copper-piping systems. Clamps in direct contact of copper piping to be copper or nylon. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, expansion shells, inserts or beam clamps selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information.
1. All beam clamps shall be installed with a retaining strap to grasp two opposing sides of structure to prevent possible movement of the clamp due to vibration.
 2. Select size of building attachments to suit hanger rods.
 3. Provide copper-plated building attachments for copper-piping systems.
 4. "C" clamps shall not be permitted except on fire protection piping.
 5. Install building attachments at required locations within concrete or on structural steel for proper piping support.
 6. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - b. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 - c. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - d. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - e. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - f. C-Clamps (MSS Type 23): For structural shapes.
 - g. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - h. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - i. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 - j. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 - k. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 - l. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - 1) Light (MSS Type 31): 750 lb.
 - 2) Medium (MSS Type 32): 1500 lb.
 - 3) Heavy (MSS Type 33): 3000 lb.
 - m. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - n. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 - o. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- p. Space attachments within maximum piping span length indicated below. Install additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. For new concrete, install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

- 1) Two or one-end threaded rod sizing for various support loads shall be as follows:

ROD DIAMETER	MAXIMUM LOAD (LBS.)
3/8"	610
1/2"	1130
5/8"	1810
3/4"	2710
7/8"	3770
1"	4960
1-1/8"	6230
1-1/4"	8000
1-1/2"	11630
1-3/4"	15700
2"	20700
2-1/4"	27200
2-1/2"	33500

Note limitations on structure supporting rods.

- 2) For reference purposes, the following table provides filled weights of steel piping for various sizes:

PIPE SIZE	FILLED PIPE WEIGHT (LB/FT)
1/2"	1.0
3/4"	1.4
1"	2.1
1-1/4"	3.0
1-1/2"	3.6
2"	5.1
2-1/2"	7.9
3"	10.8
4"	16.3
6"	31.5
8"	50.2
10"	74.6
12"	98.6
14"	114.4
16"	141.8
18"	171.9
20"	204.4
22"	240.4
24"	278.7
26"	319.8

28"	363.6
30"	410.1
32"	459.3
34"	511.3
36"	565.9

- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- P. Piping support spacing:
1. All piping shall be supported at distances not exceeding the spacing in the following table. This table is intended for general distribution piping. Within equipment rooms, hangers must be arranged to provide full support of piping. No piping is to be supported by, or impose a load upon the equipment to which it is connected.
 2. Install hangers for steel piping with the following maximum spacing and minimum rod sizes unless hanger spacing is:
 - a. Specifically indicated on drawings
 - b. Indicated in other Division 23 specification sections for special applications
 - c. Required to be more frequently by State or local codes
 3. Maximum steel piping hanger supports
 - a. NPS 3/4: Maximum span, 7 feet.
 - b. NPS 1: Maximum span, 7 feet.
 - c. NPS 1-1/2: Maximum span, 9 feet.
 - d. NPS 2: Maximum span, 10 feet.
 - e. NPS 2-1/2: Maximum span, 11 feet.
 - f. NPS 3 and Larger: Maximum span, 12 feet.
 4. Maximum drawn-temper copper piping hanger supports:
 - a. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - b. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - c. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.

- d. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - e. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - f. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - g. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- R. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- S. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- T. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
- U. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- V. Horizontal Piping: Comply with the following installation requirements.
- 1. Individual hangers for uninsulated piping not specified to be supported with roller hangers may be supported with either adjustable band hangers or adjustable steel clevis hangers.
 - 2. Individual hangers for insulated piping not specified to be supported with roller hangers shall be adjustable steel clevis hangers.
 - 3. Support the following horizontal piping using adjustable roller hanger supports MSS Type 43 for twelve (12) inches and below and MSS Type 41 for fourteen (14) inches and above:

Enter size of piping to be installed on roller hangers.

- a. Piping over 2 4 6 (choose one size) inches in size transporting medium above 150 deg. F.
 - b. All piping 4 6 8 10 (choose one size) inches in size and above, regardless of medium.
4. All piping on horizontal trapeze supports.
- W. Heavy duty trapezes may be utilized for multiple horizontal pipes where applicable. Design of same shall be by trapeze manufacturer considering weight, available structure, pipe medium, material, etc. Supports for individual piping group on trapezes shall be as specified for individual piping.
- X. Shields: Where insulation is indicated on piping, install galvanized protective shields for sizes 6" and smaller. Install thermal hanger shield inserts with same thickness as pipe insulation.
- Y. Insulated Piping: Comply with the following installation requirements.
- 1. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
 - 2. Clamps:

- a. Attach clamps and spacers to piping.
 - 1) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - 2) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 3) Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
3. Saddles for piping above ambient conditions: Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated where piping is eight (8) inches in diameter or larger, or piping of any size on roller hanger supports, install protection saddles. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers. Constructed of 360 deg insert of high density, 100 psi, water-proofed calcium silicate, encased in 360 deg sheet metal shield. Provide assembly of same thickness as adjoining insulation, with sufficient width to prevent hanger bearing on insulation.
4. Saddles for piping below ambient conditions: Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Pipes NPS 4 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield. Hardwood block saddles to be provided in sufficient width to prevent hanger bearing on insulation. Multiple hardwood block sections shall be installed on piping at angles and quantities recommended by support manufacturer.
5. Shield Dimensions for Pipe: Install MSS Type 40, protective shields. Shields shall span an arc of 180 degrees. Not less than the following lengths and thickness:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Hangers in contact with copper pipe shall be copper or nylon. Plated copper not acceptable.

- C. Hangers for refrigerant piping shall be isolated from the pipe by a non-metallic material around the piping in such a manner to protect the piping from damage due to vibration and to minimize sound transmission in the building.
- D. On uninsulated refrigerant piping, Hydra-Zorb (-65 to 275 deg F) supports to be used on any unistrut type support structures. All other insulated piping systems are to have continuous insulation with a continuous vapor barrier.
- E. Chilled water piping shall utilize specialized blocking and shield to allow proper insulation and vapor barrier to eliminate condensation (service and flow direction shall be labeled).
- F. Dual temperature service heating and cooling piping 2½" and larger shall be mounted on roller hangers.
- G. All outdoor miscellaneous metal equipment supports not indicated to be stainless steel construction shall be galvanized steel. Spray-on galvanizing shall be applied to all disturbed areas. All indoor miscellaneous metal equipment supports shall be black iron, primed and painted or galvanized.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 23 Common Work Results for HVAC and Basic HVAC Materials and Methods sections apply to work specified in this section.
- C. See also Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for seismic restraint devices for all ductwork, piping, and equipment.

1.2 SUMMARY

A. Section Includes:

- 1. Elastomeric isolation pads.
- 2. Elastomeric isolation mounts.
- 3. Restrained elastomeric isolation mounts.
- 4. Open-spring isolators.
- 5. Restrained-spring isolators.
- 6. Thrust Restraints
- 7. Pipe-riser resilient supports.
- 8. Resilient pipe guides.

Delete air spring isolators below when not applicable

- 9. Air-spring isolators.
- 10. Restrained-air-spring isolators.
- 11. Elastomeric hangers.
- 12. Spring hangers.
- 13. Snubbers.
- 14. Restraint channel bracings.
- 15. Restraint cables.

Delete seismic restraint accessories below when not applicable.

- 16. Seismic-restraint accessories.
- 17. Mechanical anchor bolts.
- 18. Adhesive anchor bolts.
- 19. Vibration isolation equipment bases.
- 20. Restrained isolation roof-curb rails.

B. Related Requirements:

- 1. Vibration control products furnished as integral part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 23 sections.

2. Refer to other Division 23 sections for equipment foundations, hangers, sealants, gaskets, and other work related to vibration control work.
3. Refer to other Division 23 sections for requirements of electrical connections to equipment isolated on vibration control products.
4. Refer to other Division 23 sections for requirements of duct connections to air handling equipment isolated on vibration control products.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

Retain below when seismic restraints and delegated design is included in the project.

- C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
 1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Design Calculations: Calculate static (gravity) and dynamic (as defined by the building code) loading due to equipment weight, operation, and seismic and wind forces to select

vibration isolators and seismic and wind restraints and for designing vibration isolation bases.

- a. Coordinate seismic design calculations with wind load calculations to optimize the restraint requirement for equipment mounted outdoors. Where appropriate, comply with requirements in other Sections for equipment mounted outdoors.
3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
4. Seismic and Wind-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

Retain seismic bracing below when Seismic Restraints are required.

- A. Coordination Drawings: Show coordination of vibration isolation device installation [**and seismic bracing**] for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

Retain two sections below when seismic restraints and delegated design is included in the project.

- B. Seismic & wind restraint field quality-control reports when applicable from a qualified factory trained individual.

- C. Qualification Data: For professional engineer.

- D. Welding certificates where applicable.

Delete below when Air-Mounts are not used on project.

- E. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data.

- F. Field quality-control reports.

Delete below when Air-Mounts are not used on project.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-spring mounts and/or restrained-air-spring mounts to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 3 years.
 - 1. Except as otherwise indicated, obtain vibration control products from single manufacturer.
 - 2. Engage manufacturer to provide technical supervision of installation of vibration control products.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

Retain below when seismic restraints are included in the project.

- D. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- E. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval ASHRAE/ANSI Standard 171-2017, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

Retain below for projects with Seismic Restraint requirements.

1.8 PERFORMANCE REQUIREMENTS

- A. For wind and seismic restraint loading criteria, refer to structural drawings. For Component Importance Factor for each item, refer to mechanical equipment schedule below.

Identify mechanical equipment and associated importance factors below.

- 1. Component Importance Factor: [1.0] [1.5] <Insert value>.
 - a. Mechanical Item...
- B. Delegated-Design: Engage a qualified engineering firm to perform a detailed analysis and certified submittal of restraining devices & mounting requirements to resist seismic and wind forces, signed and sealed by a Professional Engineer

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

Obtain the following information from the Architect / Structural Engineer for the project.

A. Wind-Restraint Loading:

1. Basic Wind Speed: <Insert value>.
2. Building Classification Category: [I] [II] [III] [IV].
3. Minimum 35 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

Retain and edit below when Seismic Restraints are required. Review requirements below with the structural engineer.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: [A] [B] [C] [D] [E] [F].
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: [I] [II] [III].
 - a. Component Response Modification Factor: [1.5] [2.5] [3.5] [5.0] <Insert value>.
 - b. Component Amplification Factor: [1.0] [2.5] <Insert value>.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): <Insert number>.
4. Design Spectral Response Acceleration at 1.0-Second Period: <Insert number>.
5. Rated strengths, features, and applications shall be as defined in reports by [an evaluation service member of ICC-ES] [ASHRAE/ANSI Standard 171-2017] [an agency acceptable to authorities having jurisdiction].

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc. (Model RSP)
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
2. Fabrication: Single or multiple layers for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Waffle pattern.
6. Load-bearing metal plates adhered to pads if required.
7. Sandwich-Core Material: Resilient and elastomeric.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc. (Model RD or RQ)
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc. (Model RDS)
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc. (Model FDS)
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.

2. Laterally-stable, wound-steel compression springs, of high-strength spring alloy steel; with spring diameter not less than 0.8 of compressed height of spring at rated loads. Provide minimum additional travel to solid, equal to 50% of rated deflection. Provide spring wire with elastic limit stress exceeding stress at solid deflection.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without permanent deformation or failure.
7. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
8. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc. (Model FHS, FLS, FLSS, or TITAN)
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
2. Design restraint bracket/isolator housing to act as blocking during erection, and with installed height and operating height being equal. Maintain 1/2 inch total (1/4 inch radial) minimum clearance around restraining bolts, and between housing and springs. Design so limit stops are out of contact during normal operation and resist all wind forces per applicable building codes. Restraining bolts shall have a neoprene bushing between the bolt and the restraint housing.
3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. If top plate type, top plate with threaded mounting holes.
 - c. If direct bolt type, extend stud with an incorporated equipment support ledge or female tapped equipment support post.
4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 THRUST RESTRAINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc. (Model HSR)
 2. Mason Industries, Inc.
 3. Vibration Eliminator Co., Inc.
- B. Provide horizontal thrust restraints consisting of spring elements in series with neoprene pad. Select spring deflection same as for equipment loading. Design so thrust restraints can be pre-set and adjusted in field. Attach horizontal restraints at centerline of thrust and symmetrically on either side of unit.

2.8 PIPE-RISER RESILIENT SUPPORT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc. (Model KPA)
 2. Mason Industries, Inc.
 3. Vibration Eliminator Co., Inc.
- B. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.
- C. Delegated design submittal signed and sealed by a Professional Engineer when indicated on contract documents showing riser diagrams (anticipated high movement piping systems or in tall buildings).

2.9 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/4-inch-thick neoprene.
1. Guides shall be capable of motion to meet location requirements.

Retain below only when applicable. Coordinate below with manufacturer as they are custom made per application.

2.10 AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Firestone Industrial Products Company.
 - c. Mason Industries, Inc.
2. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
3. Maximum Natural Frequency: 3 Hz.
4. Operating Pressure Range: 25 to 100 psig.
5. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
6. Tank valves.

Retain below only when applicable. Coordinate below with manufacturer as they are custom made per application.

2.11 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Firestone Industrial Products Company.
 - c. Mason Industries, Inc.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
9. Maximum Natural Frequency: 3 Hz.
10. Operating Pressure Range: 25 to 100 psig.
11. Burst Pressure: At least three times manufacturer's published maximum operating pressure.

Retain below when necessary, used only in very rare circumstances that will be initiated by the owner or highly sensitive equipment (research MRIs, etc. Only use on a case by case basis.

12. Tank valves.

2.12 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc. (Model RH, FH)
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and designed in a manner that will allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.13 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc. (Model SH, SRH)
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
2. Frame: Steel, fabricated for connection to threaded hanger rods and designed in a manner to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.14 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Vibration Mountings & Controls, Inc.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

2.15 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line, an Eaton business.
 2. Hilti, Inc.
 3. Kinetics Noise Control, Inc. (Model KSSB)
 4. Mason Industries, Inc.
 5. Unistrut; Part of Atkore International.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.
- C. Cannot be used in conjunction with vibration isolated equipment.

2.16 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc. (Model KSWC, KSCC)
 2. Mason Industries, Inc.
 3. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement. Use stainless steel cables for corrosive environments or locations exposed to weather.

Retain below when seismic restraints are included in the project.

2.17 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. CADDY; a brand of nVent.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries, Inc.
 - 5. TOLCO.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.18 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. Hilti, Inc.
 - 3. Kinetics Noise Control, Inc.(Model KSCCA)
 - 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.19 ADHESIVE ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hilti, Inc.
 - 2. Kinetics Noise Control, Inc. (Model KAAB)
 - 3. Mason Industries, Inc.

- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.20 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc.
 - 3. Vibration Eliminator Co., Inc.
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- D. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.21 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Thybar Corporation.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

Retain below when seismic requirements apply to the project.

- A. Examine areas and equipment to receive vibration isolation [**and seismic and wind-control**] devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PERFORMANCE OF ISOLATORS

- A. General: Comply with minimum static deflections listed in vibration control schedule or as recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.3 APPLICATIONS

- A. Except as otherwise indicated, select vibration control products in accordance with vibration control schedule and current version of ASHRAE Handbook, "Noise and Vibration Control", Table 7. Where more than one type of product is offered, selection is Installer's option.
- B. Piping: For piping connected to equipment mounted on vibration control products, install spring isolation hangers as indicated, and for first 3 points of support for pipe sizes 4 inches and less, for first 4 points of support for pipe sizes 5 inches through 8 inches, and for first 6 points of support for pipe sizes 10 inches and over.
- C. Ductwork: For ductwork connected to equipment mounted on vibration control products, provide flexible duct connections as specified under "Metal Ductwork and Accessories" section and support ductwork using spring isolation hangers for the first three hangers for ducts with the larger dimension of 24" or less and first six hangers for ductwork having a dimension greater than 24".
- D. Ferrous components including housings and hardware of vibration control devices exposed to weather to be hot-dip galvanized.
- E. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- F. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- G. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

Retain below when seismic restraints are included in the project.

3.4 VIBRATION CONTROL [AND SEISMIC-RESTRAINT] DEVICE INSTALLATION

- A. General: Except as otherwise indicated, comply with manufacturer's instruction for installation and load application to vibration control materials and units. Adjust to ensure that units have

equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

- B. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
- C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.
- D. Install inertia base frames on isolators as indicated at lowest possible mounting height, so that minimum of 1 inch clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation.
- E. For air handling equipment, install thrust restraints as indicated, and also wherever thrust exceeds 10% of equipment weight.
- F. Locate isolation hangers as near overhead support structure as possible.
- G. Weld riser isolator units in place as required to prevent displacement from loading and operations.
- H. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."] [Section 230501 "Basic HVAC Materials and Methods."]
- I. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- J. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- K. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

Retain below when seismic restraints are included in the project.

- 3. Install seismic-restraint devices using methods approved an agency acceptable to authorities having jurisdiction that provides required submittals for component.

L. Piping Restraints:

- 1. Comply with requirements in MSS SP-127.
- 2. Brace per qualified PE's delegated design, but at a minimum:

- a. Space lateral supports a maximum of [40 feet] <Insert dimension> o.c., and longitudinal supports a maximum of [80 feet] <Insert dimension> o.c.
- b. Brace a change of direction longer than 12 feet.

M. Install cables so they do not bend across edges of adjacent equipment or building structure.

Retain below when seismic restraints are included in the project.

- N. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- O. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- P. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- Q. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- R. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

Retain below when seismic restraints are included in the project.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.6 FIELD QUALITY CONTROL

Coordinate below with Owner and edit accordingly.

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least **[four]** **<Insert number>** of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. Test and adjust restrained-air-spring isolator controls and safeties.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.7 ADJUSTING AND CLEANING

- A. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.
- B. Adjust isolators after piping system is at operating weight.
- C. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- D. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

Retain below only when applicable.

3.8 AIR-SPRING ISOLATOR INSTALLATION

- A. Independent Isolator Installation:
 - 1. Install tank valve into each air isolator.

2. Inflate each isolator to height and/or pressure specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered facility or constant air supply.
3. Inflate isolators to height and/or pressure specified on Drawings.

3.9 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."] [Section 230501 "Basic HVAC Materials and Methods."]

3.10 VIBRATION ISOLATION EQUIPMENT SCHEDULE

Engineer to provide schedule of equipment requiring vibration isolation, isolator type, and deflection amount below.

A. Air Handling Unit Fans....

Table 47 Selection Guide for Vibration Isolation
Equipment Location
Floor Span

Equipment Type	Horsepower And Other	RPM	Slab on Grade			Up to 20 ft.			20 to 30 ft.			30 to 40 ft.			
			Base Type	Isolator Type	Defl., in.	Base Type	Isolator Type	Defl., in.	Base Type	Isolator Type	Defl., in.	Base Type	Isolator Type	Defl., in.	
Refrigeration Machines and Chillers															
Reciprocating	All	All	A	2	0.25	A	4	0.75	A	4	1.50	A	4	2.50	
Centrifugal, scroll	All	All	A	1	0.25	A	4	0.75	A	4	1.50	A	4	1.50	
Screw	All	All	A	1	1.00	A	4	1.5	A	4	2.50	A	4	2.50	
Absorption	All	All	A	1	0.25	A	4	0.75	A	4	1.50	A	4	1.50	
Air-cooled recip., Scroll	All	All	A	1	0.25	A	4	1.50	A	4	1.50	A	4	2.50	
Air-cooled screw	All	All	A	4	1.00	A	4	1.50	B	4	2.50	B	4	2.50	
Air Compressors and Vacuum Pumps															
Tank-mounted horiz.	≤10	All	A	3	0.75	A	3	0.75	A	3	1.50	A	3	1.50	
	≥15	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50	
Tank-mounted vert.	All	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50	
Base-mounted	All	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50	
Large reciprocating	All	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50	
Pumps															
Close-coupled	≤7.5	All	B	2	0.25	C	3	0.75	C	3	0.75	C	3	0.75	
	≥10	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50	
Inline	5 to 25	All	A	3	0.75	A	3	1.50	A	3	1.50	A	3	1.50	
	≥30	All	A	3	1.50	A	3	1.50	A	3	1.50	A	3	2.50	
End suction and Double-suction/split case	≤40	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50	
	50 to 125	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	2.50	
	≥150	All	C	3	0.75	C	3	1.50	C	3	2.50	C	3	3.50	
Packaged pump Systems	All	All	A	3	0.75	A	3	0.75	A	3	1.50	C	3	2.50	

Table 47 Selection Guide for Vibration Isolation (Continued)

		Equipment Location													
		Floor Span													
		Slab on Grade				Up to 20 ft.			20 to 30 ft.		30 to 40 ft.				
Type	Horsepower	Min.	Min.		Min.		Min.						Min.Equipment		
		Base Isolator Defl.,	Base Isolator Defl.,	Base Isolator Defl.,	Base Isolator Defl.,	Base Isolator Defl.,	Base Isolator Defl.,	Base Isolator Defl.,	Base Isolator Defl.,	Base Isolator Defl.,	Base Isolator Defl.,	Base Isolator Defl.,	Type	Type	in
		And Other	RPM	Type	Type	in.	Type	Type	in.	Type	Type	in.	Type	Type	in
Cooling Towers	All		Up to 300	A	1	0.25	A	4	3.50	A	4	3.50	A	4	3.50
			301 to 500	A	1	0.25	A	4	2.50	A	4	2.50	A	4	2.50
			501 and up	A	1	0.25	A	4	0.75	A	4	0.75	A	4	1.50
Boilers															
Fire-tube	All		All	A	1	0.25	B	4	0.75	B	4	1.50	B	4	2.50
Water-tube	All		All	A	1	0.12	A	1	0.12	A	1	0.12	B	4	0.25
Copper fin															
Axial Fans, Plenum Fans, Cabinet Fans, Fan Sections, Centrifugal Inline Fans															
Up to 22 in. diameter 24 in.diameter and up	All ≤2 in. SP		All	A	2	0.25	A	3	0.75	A	3	0.75	C	3	0.75
			Up to 300	B	3	2.50	C	3	3.50	C	3	3.50	C	3	3.50
			301 to 500	B	3	0.75	B	3	1.50	C	3	2.50	C	3	2.50
			501 and up	B	3	0.75	B	3	1.50	B	3	1.50	B	3	1.50
≥2.1 in.SP			Up to 300	C	3	2.50	C	3	3.50	C	3	3.50	C	3	3.50
			301 to 500	C	3	1.50	C	3	1.50	C	3	2.50	C	3	2.50
			501 and up	C	3	0.75	C	3	1.50	C	3	1.50	C	3	2.50
Centrifugal Fans															
Up to 22 in. diameter 24 in. diameter and up	≤40		All	B	2	0.25	B	3	0.75	B	3	0.75	B	3	1.50
			Up to 300	B	3	2.50	B	3	3.50	B	3	3.50	B	3	3.50
			301 to 500	B	3	1.50	B	3	1.50	B	3	2.50	B	3	2.50
			501 and up	B	3	0.75	B	3	0.75	B	3	0.75	B	3	1.50
≥50			Up to 300	C	3	2.50	C	3	3.50	C	3	3.50	C	3	3.50
			301 to 500	C	3	1.50	C	3	1.50	C	3	2.50	C	3	2.50
			501 and up	C	3	1.00	C	3	1.50	C	3	1.50	C	3	2.50

Table 47 Selection Guide for Vibration Isolation (Continued)

Type	Horsepower	Equipment Location Floor Span												Min.Equipment Type in		
		Slab on Grade			Up to 20 ft.			20 to 30 ft.		30 to 40 ft.						
		Base And Other	Min. Isolator RPM	Defl., Type	Base Isolator Type	Min. Defl., in.	Base Isolator Type	Min. Defl., in.	Base Isolator Type	Min. Defl., in.	Base Isolator Type	Min. Defl., in.				
Propeller Fans																
Wall-mounted		All	All	A	1	0.25	A	1	0.25	A	1	0.25	A	1	0.25	
Roof-mounted		All	All	A	1	0.25	A	1	0.25	B	4	1.50	D	4	1.50	
Heat Pumps, Fan-Coils, Computer Room Units		All	All	A	3	0.75	A	3	0.75	A	3	0.75	A/D	3	1.50	
Condensing Units		All	All	A	1	0.25	A	4	0.75	A	4	1.50	A/D	4	1.50	
Packaged AH, AC, H, and V Units																
All	≤10	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75		
	≤15	Up to 300	A	3	0.75	A	3	3.50	A	3	3.50	C	3	3.50		
	≤4 in. SP	301 to 500	A	3	0.75	A	3	2.50	A	3	2.50	A	3	2.50		
		501 and up	A	3	0.75	A	3	1.50	A	3	1.50	A	3	1.50		
	>15,	Up to 300	B	3	0.75	C	3	3.50	C	3	3.50	C	3	3.50		
	>4 in. SP	301 to 500	B	3	0.75	C	3	1.50	C	3	2.50	C	3	2.50		
Packaged Rooftop Equipment		All	All	A/D	1	0.25	D	3	0.75	D	3	1.50	D	3	2.50	

Table 47 Selection Guide for Vibration Isolation (Continued)

Type	Horsepower	Equipment Location Floor Span													
		Slab on Grade			Up to 20 ft.			20 to 30 ft.			30 to 40 ft.				
		Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	Min. Base Isolator Defl.,	
		And Other	RPM	Type	Type	in.	Type	Type	in.	Type	Type	in.	Type	Type	in.
Duct Rotating Equipment															
Small fans, fan-Powered boxes	≤600 cfm			A	3	0.50	A	3	0.50	A	3	0.50	A	3	0.50
	≥601 cfm			A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75
Engine-Driven Generators															
	All	All		A	3	0.75	C	3	1.50	C	3	2.50	C	3	3.50

Base Types:

- A. No base, isolators attached directly to equipment
- B. Structural steel rails or base
- C. Concrete inertia base
- D. Curb-mounted base

Isolator Types:

- 1. Pad, rubber, or glass fiber
- 2. Rubber floor isolator or hanger
- 3. Spring floor isolator or hanger
- 4. Restrained spring isolator
- 5. Thrust restraint
- 6. Air spring

END OF SECTION 230548

KSU DESIGNERS NOTES:

1. All roof mounted equipment shall be furnished with full perimeter curbs or rails with flexible vibration isolators. These types of systems shall be reviewed with OUA.
2. Flexible connectors for hydronic systems shall be braided Stainless Steel style; neoprene type isolators are not acceptable.

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Duct labels.
4. Valve tags.
5. Underground-type plastic line markers.
6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 8. Fasteners: Stainless-steel rivets or self-tapping screws.
 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: Size letters according to ASME A13.1 for piping. Abbreviate only as necessary for each application length.

2.3 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware or Self-Adhesive Labels: Printed plastic with contact-type, permanent-adhesive backing.
- B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

- D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- E. Fasteners: Stainless-steel rivets or self-tapping screws for engraved plastic labels.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Duct Label Contents: Include identification of duct service (supply, return, exhaust, intake, relief, etc.) using same designations or abbreviations as used on Drawings; also include designated system and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.4 VALVE TAGS

- A. Description: 1-1/2" diameter stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. Numbers to be sequenced. The tag engraving shall be filled with black enamel.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Tag Material: Plastic, 3/32-inch minimum thickness engraved plastic laminate valve tags and having predrilled or stamped holes for attachment hardware.
 - 3. Fasteners: Brass wire-link chain, brass or stainless steel beaded chain, or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system service, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), equipment or area isolated, and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.
 - 2. For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with plastic (plexiglass) panel. Submit valve schedule for Engineer's review prior to mounting.
- C. UNDERGROUND-TYPE PLASTIC LINE MARKERS:
 - 1. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
 - 2. Provide multi-ply tape consisting of solid aluminum foil core between 2 layers of plastic tape.

2.5 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature:
 - a. Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE".
 - b. For confined space identification: "Danger" with the words "Permit-Required Confined Space. Do Not Enter".
 - 4. Furnish a quantity of 24 lockout tags, professionally pre-printed with the word "Danger" in white lettering on red background with the words "Do Not Start. Equipment Locked Out" following.
 - 5. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Equipment labels shall be located where accessible and easily seen from the front of the equipment. When the equipment itself is not able to accept the label (i.e. pressure sensitive tape does not stick to the surface) the tag shall be mounted in an appropriate location on the wall. Equipment tags shall include such information as make, model, capacity, voltage, static pressure ratings, CFM, GPM, TDH, HP, Building Automation System (BAS) tag number and pressure settings based on actual system setup at time of commissioning.

- C. At Installer's option, where equipment to be identified is concealed above acoustical ceiling or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).
- D. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.
- E. Install labels on ceiling grid at VAV terminal unit locations, duct smoke detectors, differential pressure sensors, static pressure sensors and piping system isolation valves. Ceiling tag shall indicate VAV terminal designation along with thermostat Building Automation System (BAS) tag.
- F. Provide labels for the following general categories of equipment and operational devices:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Meters, gages, thermometers and similar units.
 - 3. Fuel-burning units including boilers, furnaces, heaters, stills and absorption units.
 - 4. Pumps, compressors, chillers, condensers and similar motor-driven units.
 - 5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units and similar equipment.
 - 6. Fans, blowers, primary balancing dampers and air terminal units.
 - 7. Packaged HVAC central-station and zone-type units.
 - 8. Tanks and pressure vessels.
 - 9. Strainers, filters, humidifiers, water treatment systems and similar equipment.
- G. All expansion tanks, relief valves and pressure reducing valves shall have system set pressure attached to device once final set point is complete.
- H. Equipment and air terminal devices located concealed above ceilings or access doors shall be labeled utilizing an engraved tag or printed label, black 18-point size letters, on white background, mounted on the ceiling grid or on the access door.
- I. Apply printed labels on thermostats, humidistat's, carbon dioxide sensors and other wall mounted control devices to identify the type of controller or sensor, equipment controlled and Air Handling Unit system association. Contractor to label and tag all system components to match the current or new BAS naming convention for continuity within the building complex.

3.4 CONFINED SPACE IDENTIFICATION:

- A. Furnish and install confined space identification signs in a conspicuous location where approved by Owner's authorized representative for each permit required confined space. A permit required confined space is defined as a confined space in which an employee's whole body can enter, has an entrance into or exit from the space which is restricted in any way, and is not designed for continuous employee occupancy. In addition, a permit required confined space must have the potential to contain a hazardous atmosphere, contain a material such as fluid or particles that could trap or asphyxiate an entrant, or contain any other serious safety or health hazard, such as an electrical or mechanical hazard. Examples of permit required confined

spaces requiring signs are air handling units, boilers, cooling tower sumps, underground tanks, vaults or manholes, etc.

3.5 LABEL INSTALLATION

- A. Pipe labels to be taped around pipe at both ends of label. Do not use plastic bands to hold on pipe markers.
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Locate labels near points where pipes enter into and exit from concealed spaces (fixed ceiling, shaft, underground, or similar concealment) and at maximum intervals of 50 feet in each space where pipes are exposed or concealed by removable ceiling system. Reduce intervals to 25 feet in areas of congested piping and equipment. Label piping at both sides of wall or floor penetrations.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
 - 8. Main isolation valves located concealed above ceilings or access doors shall be labeled utilizing an engraved tag or printed label, black 18-point size letters, on white background, mounted on the ceiling grid or on the access door.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping: White letters on a safety-green background.
 - 2. Condenser-Water Piping: White letters on a safety-green background.
 - 3. Heating Water Piping: White letters on a safety-green background.
 - 4. Refrigerant Piping: Black letters on a safety-orange background.
 - 5. Low-Pressure Steam Piping: Black letters on a safety-yellow background.
 - 6. High-Pressure Steam Piping: Black letters on a safety-yellow background.
 - 7. Steam Condensate Piping: Black letters on a safety-yellow background.
 - 8. Exhaust Steam: Black letters on a safety-yellow background.
 - 9. Makeup Water Piping: White letters on a safety-green background.
 - 10. Drain (A/C Condensate): White letters on a safety-green background.

3.6 DUCT LABEL INSTALLATION

- A. Install plastic-laminated or self-adhesive duct labels with permanent adhesive on air ducts in the following color codes with white text:
 - 1. Blue: For cold-air supply ducts.
 - 2. Yellow: For hot-air supply ducts.
 - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
- B. Locate labels near points where ducts enter into and exit from concealed spaces (fixed ceiling, shaft, underground, or similar concealment) and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system. Label ductwork at both sides of wall or floor penetrations.
- C. Access Doors: Provide duct labels on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.
- D. Concealed Doors: Where access doors are concealed above acoustical ceilings or similar concealment, plasticized tags may be installed for identification.

3.7 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Colors:
 - a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
 - b. Flammable Fluids: Black letters on a safety-yellow background.
 - c. Combustible Fluids: White letters on a safety-brown background.
 - d. Potable and Other Water: White letters on a safety-green background.
 - e. Compressed Air: White letters on a safety-blue background.
- C. UNDERGROUND PIPING IDENTIFICATION:
 - 1. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.8 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

PART 4 - SUPPLEMENTAL
REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
1. Identification shall comply with ANSI A13.1 for lettering size, length of color field, colors and viewing angles of identification.
 2. Coordinate exposed labels on ceiling grids, access doors, etc. with KSU OUA prior to installation.
 3. Valve Chart: A typewritten directory of all valves shall be framed under glass and wall mounted. Coordinate location with KSU OUA. The valve list shall include the valve number, type of service, size, approximate location, and equipment or area isolated. A copy of the valve chart shall be included in the O&M manual.
 4. Valve tags shall include an abbreviation for the type of service.
 - a. HVAC Systems: CW=chilled water; HW=hot water heating; ST=steam (LPS =<15 psig, MPS=>15 psig or < 65 psig; HPS >65 psig. SC=steam condensate. Add S or R to letter for supply or return when needed) (LPSC, MPSC, HPSC pressure still apply).
 - b. TW=condenser water (add S or R to letter for supply or return when needed).
 5. Flow arrows shall be reviewed by Associate prior to installation to verify proper direction and application.
 6. Pipe labels and equipment tags to be coordinated with OUA and A/E team. Colors to be as developed and specified by OUA.
 7. Painted stencils will be acceptable for duct labels in lieu of types specified above.
 8. Access doors (on the duct, not chase access doors) shall be labeled indicating access for the fire or smoke damper.
 9. Motorized smoke and fire dampers shall be labeled as such at the operator so as not to be confused with temperature control dampers.

END OF SECTION 230553

KSU DESIGNERS NOTES:

1. Color and system coordinated with OUA and A/E team.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

Retain only relevant equipment and systems below and in Part 2.

- A. Section Includes:

- 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Dual-duct systems.
 - c. Variable-air-volume systems.
 - d. Multizone systems.
 - e. Induction-unit systems.
- 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary-secondary hydronic systems.
- 3. Balancing steam systems.
- 4. Testing, Adjusting, and Balancing Equipment:
 - a. Heat exchangers.
 - b. Motors.
 - c. Chillers.
 - d. Cooling towers.
 - e. Condensing units.
 - f. Boilers.
 - g. Heat-transfer coils.
- 5. Testing, adjusting, and balancing existing systems and equipment.
- 6. Sound tests.
- 7. Vibration tests.
- 8. Duct leakage tests.
- 9. Room integrity tests.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

Edit Number of Days Below to Suit Project

- A. Qualification Data: Within **60** days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within **60** days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within **60** days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within **60** days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.

- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.
- B. TAB Specialists Qualifications: Certified by NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

- A. Subject to compliance with requirements, engage one of the following:

1. Fulton & Associates Balance Company.
2. Kahoe Air Balance Company.
3. Professional Balance Company.
4. RH Cochran and Associates, Inc.

3.2 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. **Airside:**
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 - 2. **Hydronics:**
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning per the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.

- i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- j. Variable-frequency controllers' startup is complete and safeties are verified.
- k. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE 111 and SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, triple duty valve stems, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.

- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.

3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.7 PROCEDURES FOR DUAL-DUCT SYSTEMS

A. Adjust the dual-duct systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge. On systems with separate hot-deck and cold-deck fans, verify the location of the sensor on each deck.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit's hot deck and cold deck for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for full cooling. Some controllers require starting with minimum set point. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factors as required for design cold-deck maximum airflow and hot-deck minimum airflow. Record calibration factors.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for full heating.
 - e. Measure airflow and adjust calibration factors as required for design cold-deck minimum airflow and hot-deck maximum airflow. Record calibration factors. If no minimum calibration is available, note any deviation from design airflow.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity (cooling coil or fan), adjust terminals for maximum and minimum airflow so that connected total matches cooling coil or fan selection and simulates actual load in the building.

- In systems with separate hot-deck and cold-deck fans, diversity consideration applies to each individual fan.
- c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure the fan(s) static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
 7. Set final return and outside airflow to the fan(s) while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that all terminal units are meeting design airflow under system maximum flow.
 8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.
 10. Record final fan-performance data.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure

- for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
 5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
 7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

- a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.9 PROCEDURES FOR MULTIZONE SYSTEMS

- A. Position the unit's automatic zone dampers for maximum flow through the cooling coil.
 - B. The procedures for multizone systems will utilize the zone balancing dampers to achieve the indicated airflow within the zone.
 - C. After balancing, place the unit's automatic zone dampers for maximum heating flow. Retest zone airflows and record any variances.
 - D. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
1. Measure total airflow.
 - a. Set outside-air, return-air and relief-air dampers for proper position that simulates minimum outdoor air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- E. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- F. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- G. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.
- 3.10 PROCEDURES FOR INDUCTION-UNIT SYSTEMS
- A. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.
- B. Adjust each induction unit.
- C. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

- b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- D. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
- 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- E. Balance airflow to each induction unit by measuring the nozzle pressure and comparing it to the manufacturer's published data for nozzle pressure versus cfm. Adjust the unit's inlet damper to achieve the required nozzle pressure for design cfm.
- F. Verify final system conditions.
- 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 - 4. Mark all final settings.
 - 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 - 6. Measure and record all operating data.
 - 7. Record final fan-performance data.

3.11 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 - 1. Check liquid level in expansion tank.
 - 2. Check highest vent for adequate pressure.
 - 3. Check flow-control valves for proper position.
 - 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 - 5. Verify that motor starters are equipped with properly sized thermal protection.
 - 6. Check that air has been purged from the system.

3.12 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.

- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
 - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - 1. Measure and balance coils by either coil pressure drop or temperature method.
 - 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- F. Verify final system conditions as follows:
 - 1. Re-measure and confirm that total water flow is within design.
 - 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - 3. Mark final settings.
- G. Verify that memory stops have been set.

3.13 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
- B. Adjust the variable-flow hydronic system as follows:
 - 1. Verify that the differential-pressure sensor is located as indicated.
 - 2. Determine whether there is diversity in the system.
- C. For systems with no diversity:
 - 1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:

- 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
- c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:

- a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
10. Verify that memory stops have been set.
- D. For systems with diversity:
 1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
 3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
13. Verify that memory stops have been set.

3.14 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first.
- B. Balance the secondary circuits after the primary circuits are complete.
- C. Adjust pumps to deliver total design gpm.
 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.

- c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 - D. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
 - E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.
 - F. For systems with pressure-independent valves at terminals:
 - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.
 - G. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - 1. Measure and balance coils by either coil pressure drop or temperature method.
 - 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 - H. Verify final system conditions as follows:
 - 1. Re-measure and confirm that total water flow is within design.
 - 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - 3. Mark final settings.
 - I. Verify that memory stops have been set.
- 3.15 PROCEDURES FOR STEAM SYSTEMS
- A. Measure and record upstream and downstream pressure of each piece of equipment.
 - B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

- C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- D. Check settings and operation of each safety valve. Record settings.
- E. Verify the operation of each steam trap.

3.16 PROCEDURES FOR HEAT EXCHANGERS

- A. Adjust water flow to within specified tolerances.
- B. Measure inlet and outlet water temperatures.
- C. Measure inlet steam pressure.
- D. Check settings and operation of safety and relief valves. Record settings.

3.17 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.18 PROCEDURES FOR CHILLERS

Retain condenser below when applicable

- A. Balance water flow through each evaporator **and condenser** to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 - 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 - 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 - 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.

5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.19 PROCEDURES FOR COOLING TOWERS

- A. Balance total condenser-water flows to towers. Measure and record the following data:
 1. Condenser-water flow to each cell of the cooling tower.
 2. Entering- and leaving-water temperatures.
 3. Wet- and dry-bulb temperatures of entering air.
 4. Wet- and dry-bulb temperatures of leaving air.
 5. Condenser-water flow rate recirculating through the cooling tower.
 6. Cooling-tower spray pump discharge pressure.
 7. Condenser-water flow through bypass.
 8. Fan and motor operating data.

3.20 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.21 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
 1. Measure and record entering- and leaving-water temperatures.
 2. Measure and record water flow.
 3. Record relief valve pressure setting.
- B. Steam Boilers:
 1. Measure and record entering-water temperature.
 2. Measure and record feed water flow.
 3. Measure and record leaving-steam pressure and temperature.
 4. Record relief valve pressure setting.

3.22 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 1. Entering- and leaving-water temperature.
 2. Water flow rate.

3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

Coordinate with Owner if Sound Testing is Required and the number of locations.

3.23 SOUND TESTS

A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at [5] [10] [15] <Insert number> locations as designated by the Architect.

B. Instrumentation:

1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).
3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.

4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands [63 Hz to 8000 Hz (NC)] [31.5 Hz to 4000 Hz (RC)] with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands [63 Hz to 8000 Hz (NC)] [31.5 Hz to 4000 Hz (RC)] with the equipment operating.
7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.
 - d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on [NC] [RC] worksheet with equipment on and off.

Coordinate with Owner if Vibration Testing Is Required and on what HP Size

3.24 VIBRATION TESTS

- A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than [10] [15] [25] <Insert number>.
- B. Instrumentation:
 1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
 2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
 3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
 4. Verify calibration date is current for vibration meter before taking readings.
- C. Test Procedures:
 1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
 2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial

reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.

3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.
5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.25 DUCT LEAKAGE TESTS

- A. In coordination with the installation of the duct systems, the balancing company shall perform complete duct leakage tests. The leakage tests shall be conducted on all duct systems with 2 w.g. class and above. Results shall be submitted to the Architect prior to any ducts being concealed by ceilings etc. The following duct leak testing procedure may be used in lieu of the procedure outlined in the SMACNA manual.
- B. Maximum allowable leakage shall be 1% of the total system design cfm for high pressure systems, 2% for medium pressure systems. Maximum test pressure shall be 10% above the duct system class pressure rating.
- C. Test equipment shall consist of:
1. A blower having minimum capacity of 2% of the total system air quantity for high pressure systems and 5% for low pressure systems.
 2. Orifice plates or other acceptable calibrated airflow capacity testing device for a range of 0.1% to 2% or 5% of the systems capacity as required.
 3. Two gages, one to read the duct S.P. in w.g. the other to the air flow measuring device except if direct reading instruments are used. Also a thermometer.
 4. Dampening device or other provision to slowly raise duct S.P. in w.g. to the requested level.
 5. The set shall be installed in a package and shall have approval regarding its capacity. It shall include all parts (not listed above) required for testing, e.g. flexible connection, extension cord, starter, pilot light, etc.
- D. Test equipment shall follow the outline given below:
1. Use the design drawings to determine the air capacity and indicate the allowable leakage in cfm on a chart. Select the proper airflow measuring device, size of orifices, etc., and show on the same chart, provide space also for the final leak and duct S.P. recording.

2. The Sheet Metal Contractor shall close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
3. Start the blower with its control damper closed.
4. Gradually open the inlet damper until the duct pressure reaches limits outlined above.
5. Hold this pressure for ten minutes. This brief overloading should reveal marginally constructed joints.
6. Survey all joints for audible leaks. Mark each leak for repair by the Sheet Metal Contractor after shutting down the blower. Do not apply a retest until sealants have set.
7. Read the pressure differential across the orifice or other measuring device, compare the data with cfm chart prepared for allowable leak. If cfm is exceeded, further seal is necessary.
8. Request leak test certification from the manufacturer of the mixing units. If this is not available, then carry on the test at random for one of each sizes by blocking off the low pressure side of the outlets. Proceed the same way as described above.

3.26 PROCEDURES FOR ROOM INTEGRITY TESTS

- A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected. Conduct a pressure test in the space before the ceiling is installed to verify the integrity of the envelope. Portable fans or the equipment installed for the project may be used.
- B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply and exhaust airflows to achieve the indicated conditions.
- C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
 1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
 2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 3. Test room pressurization first, then zones, and finish with building pressurization.
- D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust airflow to achieve the indicated pressure or airflow difference.
- E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
 1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
 2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test over-pressurization and under-pressurization, and observe and report on the system's ability to revert to the set point.

3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
- F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
- G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.27 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 3. Check the refrigerant charge.
 4. Check the condition of filters.
 5. Check the condition of coils.
 6. Check the operation of the drain pan and condensate-drain trap.
 7. Check bearings and other lubricated parts for proper lubrication.
 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 4. Balance each air outlet.

3.28 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply systems shall be balanced so that:
 - a. The total quantity to each space is within -5% to +10% of design values.
 - b. If two or more outlets in space, each outlet is within -5% to +10% of design value.
 - c. Supply fans are within -5% to +5% of scheduled value.
 2. Exhaust and return systems shall be balanced so the total quantity from each space is -5% to +10% of design values.
 - a. The total quantity from each space is -5% to +10% of design values.
 - b. Exhaust and return fans are within -5% to +5% of schedule values.
 3. Minimum outdoor air quantity shall be balanced so that the obtained quantity is +or - 5% of the scheduled value.
 4. Adjust Hydronic Systems to the following tolerances:
 - a. Heating or Cooling System under 100 gpm 0% to +10% of design value.
 - b. Heating or Cooling System 100 gpm and over 0% to +5% of design value.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.29 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.

4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.

- h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
- 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.

F. Apparatus-Coil Test Reports:

- 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
- 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.

- e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
- 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- K. Air-Terminal-Device Reports:
- 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
- 1. Unit Data:

- a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
- a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
- a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
2. Test Data (Indicated and Actual Values):
- a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.30 VERIFICATION OF TAB REPORT

Edit the following two paragraphs or delete if not necessary

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of **[Architect] [Owner] [Construction Manager] [commissioning authority]**.
- B. **[Architect] [Owner] [Construction Manager] [Commissioning authority]** shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:
 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
- F. Prepare test and inspection reports.

3.31 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 SUPPLEMENTAL REQUIREMENTS:

- A. Obtain approval from Engineer and Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

4.2 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. All testing shall be done to AMCA standards, specifications shall indicate TAB contractor to be certified.
- C. TAB contractor shall have performed work at KSU in the past and 5 years' minimum experience will be required.
- D. All balance reports are to indicate the type of instruments to be used and last time equipment has been calibrated.
- E. Tab contractor to provide testing methods and shall review documents so all testing ports are present and that the specifications and contract documents are complete. If deficiencies are found, contractor is to notify engineer of record, CxA agent, and Owner so the required equipment gets installed prior to testing.
- F. Reports shall be submitted in hard copies and in electronic format to the engineer of record, CxA agent if present on project and to OUA as part of the closeout documents.
- G. Diffuser throw directions and grille/register louvers shall be adjusted to the proper position by the balance contractor.
- H. Mark equipment and balancing devices, including damper-control positions, valve position indicators, triple duty valve stems, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- I. HVAC Contractor is responsible to acquire and replace sheaves based on initial balance information provided by testing organization on driven air equipment requiring same in order to comply with these specifications regarding balance tolerances.

END OF SECTION 230593

KSU DESIGNERS NOTES:

- 1. Coordinate in specifications whether balancer or equipment provider is responsible for sheave changeouts during balancing.

2. Specifications shall indicate the qualifications needed to perform work associated with the type of project being installed.
3. Failure of Associate to coordinate with Tab contractor during the shop drawings and coordination-drawing phase of the project will be addressed as an error in the design process.

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following duct services:

Retain relevant portions below to project

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

- B. Related Sections:

Retain Sections in subparagraphs below that contain requirements Contractor might expect to find in this Section but are specified in other Sections.

1. Section 230501 "Basic Mechanical Materials and Methods for HVAC" for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Section 230501 "Basic Mechanical Materials and Methods for HVAC" for sound stopping materials and requirements.
3. Section 230716 "HVAC Equipment Insulation."
4. Section 230719 "HVAC Piping Insulation."
5. Section 233113 "Metal Ducts" for duct liners.
6. Refer to drawing "Duct Material" schedules which indicate ducts to be insulated.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Firm with at least 3 years successful installation experience on projects with mechanical insulations similar to that required for this project. Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DEFINITIONS:

- A. Concealed: Ductwork and plenums concealed from normal view above ceilings and in chases.
- B. Exposed: Ductwork and plenums exposed to view in finished areas, including mechanical and electrical equipment rooms. Attics and crawl spaces where central station air handling units are located are considered to be mechanical equipment rooms.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site. Insulation made wet or damaged even after installation shall be removed and replaced.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

Retain below ONLY if self-adhered outdoor jackets are required on exterior ductwork.

1.9 WARRANTY

- A. Self-Adhering Weatherproofing System shall be provided with a five year warranty on any ductwork insulation exposed to outdoor conditions for both labor and materials if waterproof seal fails for any reason. Contractor to provide annual inspection during warranty period for exposed ductwork.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type II for sheet materials. Maximum thermal conductivity (k-value) $k=0.28$ at 75 F mean, up to 200 F for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.

- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Maximum thermal conductivity (k-value) $k=0.31$ at 75 F mean, up to 250 F, 0.75 PCF density minimum. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA maximum thermal conductivity (k-value) $k=0.26$ at 75 F mean, up to 250 F, 3.0 PCF density minimum; Type 1B maximum Thermal conductivity (k-value) $k=0.47$ at 300 F mean, up to 850 F, 2.8 PCF density minimum. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
- I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Maximum Thermal conductivity (k-value) at 100 deg F is 0.30 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. GLT Products.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Knauf Insulation.
 - e. Manson Insulation Inc.
 - f. Owens Corning.

Retain section below ONLY if fire-rated insulation systems are included in the project. Select whether fire rated insulation system is to be 1 or 2 hour rated.

2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a [1] [2]-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M.
 - b. CertainTeed Corporation.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Nelson Firestop; a brand of Emerson Industrial Automation.
 - e. Thermal Ceramics.
 - f. Unifrax Corporation.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm at manufacturer's recommended dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 2. Service Temperature Range: 0 to plus 180 deg F.
 3. Color: White.

2.6 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
- B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I for temperatures below ambient and Type II for temperatures above ambient, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.
- D. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - 2. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.
 - a. Factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

Retain below ONLY if self-adhered outdoor jackets are required on exterior ductwork.

- E. Self-Adhesive Outdoor Jacket: Acrylic adhesive, zero permeability, absolute vapor barrier, UV stable for exterior and interior applications, sheet-type waterproofing membrane consisting of a 5-ply, self-adhesive material, stucco-embossed, UV-resistant aluminum weathering surface. Color to be selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, provide by VentureClad 1577CW.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches.

2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 3. Insulation-Retaining Washers: Self-locking washers formed from 0.015-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel, or 0.062-inch soft-annealed, galvanized steel.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A167 or ASTM A240/A240M, provide in stainless steel finish to match jacket.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes according to manufacturer's written instructions with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules. Unless otherwise indicated, furnish and install insulations of the same type for the same service throughout this work.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied integral jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

- 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Insulation Terminations: Seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder. No exposed fiberglass will be permitted.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" and Section 230501 "Basic Mechanical Materials and Methods for HVAC".

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Taper termination and seal insulation ends for ducts with vapor-retarder mastic.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping" and Section 230501 "Basic Mechanical Materials and Methods for HVAC".

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Follow the manufacturer's written instructions for applying insulation.
- B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Coat exposed outdoor flexible elastomeric insulation with two coats of manufacturer's recommended protective white coating.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 1. Install cupped-head pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 2. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 3. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
 6. Apply vapor-retarder mastic for ducts other than flues to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 2. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

3. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
4. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
5. Apply vapor-retarder mastic for ducts other than flues to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

Retain below ONLY if self-adhered outdoor jackets are required on exterior ductwork.

3.8 INSTALLATION OF SELF-ADHESIVE WATERPROOF OUTDOOR JACKETS

- A. General – Refer to manufacturer's installation requirements for additional information.
- B. Surface Preparation
 1. Ensure that all surfaces are dry and clean, free from dust, oil and grease/silicone. All insulation to be taped securely, giving an even surface for the self-adhesive jacket application. All adhesives to be firmly "wetted out" to the substrate surfaces.
 2. When applying, partly peel back and crease the liner so enough adhesive is available to attach the self-adhesive jacket in the correct position. Then, with a spreader, progressively remove the liner while smoothing, until the entire sheet has been applied.

3. When applying self-adhesive jacket sheet onto a continuous surface until it meets itself, a 3 inch (75mm) overlap to give a strong, weatherproof seal. Plan the wrap so that the edge of the sealing flap faces down.

C. Application to Rectangular Ductwork

1. Top of the duct shall be crowned (pitched), to allow water runoff, preventing pooling.
2. Self-adhesive jacket should be applied to each of the sides separately, starting with the bottom surface, then the sides, and finally the top.
3. Pre-cut the self-adhesive jacket to the required size, plus an additional overlap of 3 inches for each adjoining surface.
4. When applying to rectangular ductwork, apply to the bottom surface first, bringing the 3 inch overlap over onto the top surface. Finally, apply self-adhesive jacket to the top of the duct, spreading toward the edges before trimming at the corners.

D. Application to Pipe/Circular Section Ductwork

1. On straight pipe, cut self-adhesive jacket to the desired length (pipe circumference), plus an additional overlap of 3 inches.
2. Apply the next piece allowing a 3 inch overlap onto the previous section.
3. On bends and elbow configurations, pre-cover the pipe insulation with self-adhesive jacket. Cut out the required shapes to cover the segments of the bends and elbows and apply.

E. Repairs

1. Repair of self-adhesive jacket should damage occur, simply ensure that the surface is clean, and apply a new section of self-adhesive jacket over the damaged area, to minimum of 3 inches past the damage site.

Retain section below ONLY if fire-rated insulation systems are included with project.

3.9 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct and install per manufacturer's written instructions.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping" and Section 230501 "Basic Mechanical Materials and Methods for HVAC".

3.10 FINISHES

Edit and retain two paragraphs below ONLY if insulation or field applied jackets are to be painted. Coordinate with Architect for referenced Division 09 Specifications.

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating for outdoor installations.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums, casings, terminal boxes, filter boxes, and sections.
5. Flexible connectors.

6. Vibration-control devices.
7. Factory-insulated access panels and doors.
8. Testing agency labels and stamps.
9. Nameplates and data plates.
10. Access panels and doors in air-distribution systems.

ONLY retain below where exposed supply air ductwork is not required to be insulated. Review with Owner as condensation could form on ducts pending on indoor conditions, tightness of building envelope, etc. KSU typically insulates all ductwork in this category with exposed double wall ductwork or external duct board / wrap to prevent the possibility of condensation.

11. Exposed supply air ductwork in conditioned locations without ceilings or below ceilings.

3.13 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. General: Where more than one material is indicated for a particular service, choice of listed material is installers option, unless otherwise indicated in duct material schedule on drawings.
- B. Insulate terminal duct reheat coil casings matching adjoining supply air ductwork insulation.

Retain only portions below relevant to project. SEE NOTE ABOVE REGARDING EXPOSED DUCT IN CONDITIONED AREAS AND EDIT BELOW ACCORDINGLY.

C. Supply-Air Systems

1. Concealed, round and flat-oval, supply-air duct insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Concealed, rectangular, supply-air duct insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Concealed, supply-air plenum insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
4. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 - b. Mineral-Fiber Pipe and Tank: 2 inches thick.
5. Exposed, rectangular, supply-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
6. Exposed, supply-air plenum insulation shall be the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

D. Return Air Systems

1. Concealed, round and flat-oval, return-air duct insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Concealed, rectangular, return-air duct insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Concealed, return-air plenum insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
4. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 - b. Mineral-Fiber Pipe and Tank: 2 inches thick.
5. Exposed, rectangular, return-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
6. Exposed, return-air plenum insulation shall be the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

E. Outside-Air Systems

1. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Concealed, rectangular, outdoor-air duct insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Concealed, outdoor-air plenum insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
4. Exposed, round and flat-oval, outdoor-air duct insulation shall be one of the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 - b. Mineral-Fiber Pipe and Tank: 2 inches thick.
5. Exposed, rectangular, outdoor-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
6. Exposed, outdoor-air plenum insulation shall be the following:

- a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

F. Exhaust Air Systems

1. Concealed, round and flat-oval, exhaust-air duct insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Concealed, exhaust-air plenum insulation shall be the following:
 - a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Exposed, round and flat-oval, exhaust-air duct insulation shall be one of the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 - b. Mineral-Fiber Pipe and Tank: 2 inches thick.
4. Exposed, rectangular, exhaust-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
5. Exposed, exhaust-air plenum insulation shall be the following:
 - a. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

G. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

H. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket; thickness as required to achieve fire rating of **[1]** or **[2]** hours. Install in two layers in compliance with ASTM E 2336.

I. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket; thickness as required to achieve fire rating of **[1]** or **[2]** hours. Install in two layers in compliance with ASTM E 2336.

3.14 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Ductwork installed within crawl-spaces underneath occupied areas apply to this section.
- B. Where more than one material is indicated for a particular service, choice of listed material is installers option, unless otherwise indicated in duct material schedule on drawings.
- C. Tops of insulated ducts shall be crowned (pitched), to allow water runoff, preventing pooling.
- D. Supply-Air Systems

1. Concealed, round and flat-oval, supply-air duct insulation shall be the following:

- a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
2. Concealed, rectangular, supply-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
3. Concealed, supply-air plenum insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
4. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
 - b. Mineral-Fiber Pipe and Tank: 3 inches thick.
5. Exposed, rectangular, supply-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
6. Exposed, supply-air plenum insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

E. Return Air Systems

1. Concealed, round and flat-oval, return-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
2. Concealed, rectangular, return-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
3. Concealed, return-air plenum insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
4. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
 - b. Mineral-Fiber Pipe and Tank: 3 inches thick.
5. Exposed, rectangular, return-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
6. Exposed, return-air plenum insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

F. Outside-Air Systems

1. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
2. Concealed, rectangular, outdoor-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
3. Concealed, outdoor-air plenum insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
4. Exposed, round and flat-oval, outdoor-air duct insulation shall be one of the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
 - b. Mineral-Fiber Pipe and Tank: 3 inches thick.
5. Exposed, rectangular, outdoor-air duct insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
6. Exposed, outdoor-air plenum insulation shall be the following:
 - a. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

Edit field applied jacket requirements for ductwork and indicate on drawings. Typically these will be left as none.

C. Ducts and Plenums, Concealed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.

D. Ducts and Plenums, Exposed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch [0.024 inch] thick.

4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

Edit field applied jacket requirements for outdoor ductwork and indicate on drawings.

- C. Ducts and Plenums, Concealed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.

- D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
2. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
3. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.
4. Self-Adhered Outdoor Laminated Jacket.

- E. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. [Painted] Aluminum, [Smooth] [Stucco Embossed] with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.032 inch] [0.040 inch] thick.
2. Stainless Steel, [Type 304] [or] [Type 316], [Smooth] [Stucco Embossed], with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.020 inch] [0.024 inch] thick.
3. Self-Adhered Outdoor Laminated Jacket.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

- B. Low VOC to meet LEED requirements shall be required in all installations.
- C. Any location of insulation exposed to weather, fluids (blow-downs), maintenance abuse (standing) shall be protected by a suitable jacket system

END OF SECTION 230713

KSU DESIGNERS NOTES:

1. Do not use ductliner on insides of ductwork unless on low velocity transfer air ducts.
2. The following duct systems shall be insulated:
 - a. Outside air intake ductwork and plenums, utilize rigid board insulation with weld on pins.
 - b. Supply air ductwork.
 - c. Return air ductwork when located in unconditioned areas.
 - d. Relief air ductwork within 5'-0" of relieve louver.
 - e. Boiler breaching and thimbles as required by NFPA and state codes, and shall be reviewed by OUA. All breeching shall be designed for condensate removal and treatment were required.
 - f. Other duct systems as directed by OUA.
3. Internal duct liners shall not be used except in rare cases and approved by OUA. When used they should be fiber lock or closed cell elastomeric type with antimicrobial coating and all end seams shall be sealed. NO exposed insulation will be accepted. Use of double wall duct design may be used and all insulated ductwork designs shall be reviewed with OUA.
4. Rigid insulation shall be used in all exposed locations unless otherwise approved by OUA.
5. Duct insulation thickness shall be increased in areas of above normal ambient temperature such as attics or near major steam pressure reducing stations to reduce heat gain.
6. All insulation thicknesses and densities shall be selected to meet or exceed the energy reductions of current House Bill 251 and ASHRAE 90.1 2010/2013 and utilize ecologically friendly technology when possible. Review with the OUA.
7. Ductwork located outside exposed to weather shall be designed for wind loading, snow and ice loading, and shall be 100% water proof and shall be designed to shed rain water off any horizontal ductwork being installed. Ductwork passing through roof or exterior walls shall have design details and coordinated with project architect. All HVAC designs shall be incorporated with architectural flashing details when applicable.

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following HVAC equipment that is not factory insulated:

Retain relevant portions below to project

1. Chillers.
2. Heat exchangers.
3. Converters.
4. Chilled-water pumps.
5. Condenser-water pumps.
6. Dual-service heating and cooling pumps.
7. Heating, hot-water pumps.
8. Heat-recovery pumps.
9. Steam condensate pumps.
10. Expansion/compression tanks.
11. Air separators.
12. Thermal storage tanks.
13. Deaerators.
14. Steam condensate tanks.
15. Steam flash tanks, flash separators, moisture separators, and blow-off tanks.
16. Piping system filtration unit housings.
17. Outdoor, aboveground, heated, fuel-oil storage tanks.

- B. Related Sections:

Retain Sections in subparagraphs below that contain requirements Contractor might expect to find in this Section but are specified in other Sections.

1. Section 230713 "Duct Insulation."
2. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Firm with at least 3 years successful installation experience on projects with mechanical insulations similar to that required for this project. Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
- C. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site. Insulation made wet or damaged even after installation shall be removed and replaced.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - 2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I. Maximum thermal conductivity (k-value) $k=0.33$ at 75 F mean, up to 900 F.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials. Maximum thermal conductivity (k-value) $k=0.28$ at 75 F mean, up to 200 F for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Maximum thermal conductivity (k-value) $k=0.31$ at 75 F mean, up to 250 F.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.

- c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
- I. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type V, without factory-applied jacket. Maximum thermal conductivity (k-value) $k=0.68$ at 500 F mean, up to 1000 Deg F.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Rockwool International.
 - d. Owens Corning.
- J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA maximum thermal conductivity (k-value) $k=0.26$ at 75 F mean, up to 250 F or Type IB maximum thermal conductivity (k-value) $k=0.47$ at 300 F mean, up to 850 F. Provide insulation with factory-applied FSJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
- K. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type III, without factory-applied jacket. Maximum thermal conductivity (k-value) $k=0.68$ at 500 F mean, up to 1000 F.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Industrial Insulation Group, LLC (IIG-LLC).
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Rockwool International.
 - e. Owens Corning.
- L. Mineral-Fiber, Preformed Pipe Insulation:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.

- c. Manson Insulation Inc.
 - d. Owens Corning.
- 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Maximum thermal conductivity (k-value) $k=0.25$ at 100 F mean. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 3. Type II, 1200 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type II, Grade A, with factory-applied ASJ or ASJ-SSL. Maximum thermal conductivity (k-value) $k=0.25$ at 100 F mean. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- M. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. GLT Products.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Knauf Insulation.
 - e. Manson Insulation Inc.
 - f. Owens Corning.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
 - 3. Service Temperature Range: 0 to plus 180 deg F.
 - 4. Color: White.

2.6 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
- B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

e. Factory-Fabricated Fitting Covers:

- 1) Same material, finish, and thickness as jacket.
- 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
- 3) Tee covers.
- 4) Flange and union covers.
- 5) End caps.
- 6) Beveled collars.
- 7) Valve covers.
- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.

- a. Factory cut and rolled to size.
- b. Material, finish, and thickness are indicated in field-applied jacket schedules.
- c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
- e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Width: 3 inches.

2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.015-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel, or 0.062-inch soft-annealed, galvanized steel.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A167 or ASTM A240/A240M, matching insulating jacket material type.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes according to manufacturer's written instructions with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
2. Protect exposed corners with secured corner angles.
3. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
5. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
6. Stagger joints between insulation layers at least 3 inches.
7. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

8. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 9. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Insulate pumps with fabricated removable/reusable flexible elastomeric pump cover. Cover to be conforming to equipment contours, tight fitting complete with velcro closures.

3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

- A. Insulation Installation on Boiler Breechings:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
 2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
 3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

Edit and retain two paragraphs below ONLY if insulation or field applied jackets are to be painted. Coordinate with Architect for referenced Division 09 Specifications.

- A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating for outdoor installations.
- D. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

Retain only portions relevant to project.

3.9 BREECHING INSULATION SCHEDULE

- A. Round, exposed breeching and connector insulation shall be one of the following:
 - 1. Calcium Silicate: 4 inches thick.
 - 2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
 - 3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft nominal density.
- B. Round, concealed breeching and connector insulation shall be one of the following:
 - 1. Calcium Silicate: 4 inches thick.
 - 2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
 - 3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft nominal density.

- C. Rectangular, exposed breeching and connector insulation shall be one of the following:
 - 1. Calcium Silicate: 4 inches thick.
 - 2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
 - 3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
- D. Rectangular, concealed breeching and connector insulation shall be one of the following:
 - 1. Calcium Silicate: 4 inches thick.
 - 2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
 - 3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

3.10 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.

Edit below as it pertains to chiller specified and options selected. Many chiller manufacturers offer pre-insulation of these components if specified. The following section requires that these pieces be field insulated in lieu of from factory.

- C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, **condenser bundles,** **heat-recovery bundles,** suction piping, compressor inlets, tube sheets, water boxes, and nozzles with the following:
 - 1. Flexible Elastomeric: 1 inch thick.
- D. Heat-exchanger (water-to-water for cooling service) insulation shall be the following:
 - 1. Mineral-Fiber Pipe and Tank: 1 inch thick.
- E. Heat-exchanger (water-to-water for heating service) insulation shall be one of the following:
 - 1. Calcium Silicate: 3 inches thick.
 - 2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Pipe and Tank: 2 inches thick.
- F. Steam-to-hot-water converter insulation shall be one of the following:
 - 1. Calcium Silicate: 3 inches thick.
 - 2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Pipe and Tank: 3 inches thick.
- G. Hot-water-to-steam converter insulation shall be one of the following:
 - 1. Calcium Silicate: 3 inches thick.
 - 2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Pipe and Tank: 3 inches thick.
- H. Chilled-water pump insulation shall be the following:

1. Flexible Elastomeric: 1 inch thick.
- I. Condenser-water pump insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.
 - J. Dual-service heating and cooling pump insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.
 - K. Heating-hot-water pump insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.
 - L. Heat-recovery pump insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.
 - M. Steam condensate pump and boiler feedwater pump insulation shall be one of the following:
 1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 2. Mineral-Fiber Pipe and Tank: 2 inches thick.
 - N. Chilled-water expansion, compression, and buffer tank insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.
 - O. Condenser-water expansion, compression, and buffer tank insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.
 - P. Dual-service heating and cooling expansion, compression, and buffer tank insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.
 - Q. Heating-hot-water expansion, compression tank, and buffer insulation shall be the following:
 1. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
 2. Mineral-Fiber Pipe and Tank: 1 inch thick.
 - R. Heat-recovery expansion, compression, and buffer tank insulation shall be one of the following:
 1. Flexible Elastomeric: 1 inch thick.
 2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
 - S. Chilled-water air-separator insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.

- T. Condenser-water air-separator insulation shall be the following:
1. Flexible Elastomeric: 1 inch thick.
- U. Dual-service heating and cooling air-separator insulation shall be the following:
1. Flexible Elastomeric: 1 inch thick.
- V. Heating-hot-water air-separator insulation shall be one of the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 2. Mineral-Fiber Pipe and Tank: 2 inches thick.
- W. Heat-recovery air-separator insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
- X. Thermal storage tank (brine, water, ice) insulation shall be one of the following:
1. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
 2. Mineral-Fiber Pipe and Tank: 3 inches thick.
- Y. Deaerator insulation shall be one of the following:
1. Calcium Silicate: 3 inches thick.
 2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 3 inches thick.
- Z. Steam condensate tank and receiver insulation shall be one of the following:
1. Calcium Silicate: 3 inches thick.
 2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 3 inches thick.
- AA. Steam flash-tank, flash-separator, moisture-separator, and blow-off-tank insulation shall be one of the following:
1. Calcium Silicate: 3 inches thick.
 2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.
 3. Mineral-Fiber Pipe and Tank: 3 inches thick.
- BB. Piping system filter-housing insulation shall be one of the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 2. Mineral-Fiber Pipe and Tank: 2 inches thick.
- CC. Outdoor, aboveground, heated, fuel-oil storage tank insulation shall be one of the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
 2. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

Edit special jacket requirements for equipment here and on drawings including which services. Typically not required in most cases.

C. Equipment, Concealed:

- 1. None.
- 2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.
- 3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.
- 4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.
- 5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.
- 6. <Insert jacket type>.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

- 1. None.
- 2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.
- 3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.
- 4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.
- 5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.
- 6. <Insert jacket type>.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

- 1. None.
- 2. [Painted] Aluminum, [Smooth] [Stucco Embossed] with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.020 inch] [0.032 inch] [0.040 inch] thick.
- 3. Stainless Steel, [Type 304] [or] [Type 316], [Smooth] [Stucco Embossed], with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.020 inch] [0.024 inch] thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

Edit jacket requirements for equipment here and on drawings including which services.

C. Equipment, Concealed:

1. None.
2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.
4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.
5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. [Painted] Aluminum, [Smooth] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.
2. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. [Painted] Aluminum, [Smooth] [Stucco Embossed] with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.032 inch] [0.040 inch] thick.
2. Stainless Steel, [Type 304] [or] [Type 316], [Smooth] [Stucco Embossed], with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.020 inch] [0.024 inch] thick.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

1. Insulate flash tank and vent piping indoors and outdoors for personnel protection.

END OF SECTION 230716

KSU DESIGNERS NOTES:

1. Equipment and expansion tanks, chilled water pumps, air separators, heat exchangers, condensate pump tanks, pressure powered pumps, standard

commercial domestic water heaters and storage tanks shall also be provided with insulation.

2. Boiler breaching and thimbles as required by NFPA and state codes, and shall be reviewed by OUA. All breeching shall be designed for condensate removal and treatment were required.

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:

Retain relevant portions below to project

1. Condensate drain piping.
2. Chilled-water and brine piping.
3. Condenser-water piping.
4. Makeup-water piping.
5. Heating hot-water piping.
6. Steam and steam condensate piping.
7. Refrigerant suction and hot-gas piping.
8. Dual-service heating and cooling piping.
9. Heat-recovery piping.
10. Heated fuel-oil piping.
11. Boiler feedwater piping.
12. Flash steam piping.
13. Hot overflow piping.
14. Hot drain piping.

- B. Related Sections:

Retain Sections in subparagraphs below that contain requirements Contractor might expect to find in this Section but are specified in other Sections.

1. Section 230501 "Basic Mechanical Materials and Methods for HVAC" for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Section 230501 "Basic Mechanical Materials and Methods for HVAC" for sound stopping materials and requirements.
3. Section 230713 "Duct Insulation."
4. Section 230716 "HVAC Equipment Insulation."
5. Section 232113.13 "Underground Hydronic Piping" for loose-fill pipe insulation in underground piping outside the building.
6. Section 336313 "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Firm with at least 3 years successful installation experience on projects with mechanical insulations similar to that required for this project. Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site. Insulation made wet or damaged even after installation shall be removed and replaced.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Maximum thermal conductivity (k-value) $k=0.28$ at 75 F mean, up to 200 F. Comply with ASTM C534, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Maximum thermal conductivity $k=0.25$ at 100 F mean. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type II, Grade A, with factory-applied ASJ or ASJ-SSL. Maximum thermal conductivity $k=0.25$ at 100 F mean. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. GLT Products.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Knauf Insulation.
 - e. Manson Insulation Inc.
 - f. Owens Corning.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.

- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 3. Service Temperature Range: 0 to plus 180 deg F.
 - 4. Color: White.

2.6 SEALANTS

- A. Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
- B. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I for piping temperatures below ambient and Type II for piping above ambient, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 1-piece 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
 1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
 2. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.
 - a. Factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.

- c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
- e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

- A. Bands:
 - 1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.
 - 2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
 - 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy, or 0.062-inch soft-annealed, stainless steel, or 0.062-inch soft-annealed, galvanized steel.

2.11 MINERAL WOOL REMOVABLE/REUSEABLE CONTOUR FIT INSULATION COVERS:

- A. Covers shall conform to shape of device covered. Inner and outer jacketing and gussets shall be ATC Steamguard-1 cloth. Insulation shall be 2" thick 6 lb. density Cera-wool. Thread shall be 3-ply Nomex thread. Seam fasteners shall be Steamguard-1 belts with double stainless steel welded D-rings. Furnish with stainless steel I.D. tags with embossed lettering, riveted to flaps. Wire jackets into place.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules. Unless otherwise indicated, furnish and install insulations of the same type for the same service throughout this work.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs. Do not staple longitudinal laps on insulation having a vapor retarder. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied integral jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, do not apply staples. Secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges, unions, valves, and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.

- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping" and Section 230501 "Basic Mechanical Materials and Methods for HVAC" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping" and Section 230517 "Sleeve and Sleeve Seals for HVAC".

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers and suction diffusers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers and suction diffusers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover to allow removal of basket. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable/reusable covers where indicated, selected specifically for the intended service. Each cover shall be easily removed and reapplied with a closely contoured fit for optimal thermal performance and aesthetics. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
- 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION
- A. Follow manufacturer's written instructions for applying insulation.
- B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available according to the manufacturer's written instructions.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

F. Coat exposed outdoor flexible elastomeric insulation after adhesive has fully cured with two coats of manufacturer's recommended protective white coating.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
5. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet (4.5 to 6 m) to form a vapor retarder between pipe insulation segments.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
5. See flexible elastomeric insulation application for additional valve and specialty information.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
3. Cover fittings with standard PVC fitting covers. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retardant mastic.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.
5. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.
7. See flexible elastomeric insulation application for additional valve and specialty information.

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive for a completely sealed waterproof installation. Completely sealed system shall comply with requirements of USDA and FDA.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof

sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

Edit and retain below ONLY if insulation or jackets are to be painted

3.9 FINISHES

- A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating for outdoor installations.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Flexible connectors on other than cold piping systems.
 - 4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- C. HVAC Insulation Omitted: Omit insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinet provided piping is located over drain pan; and on heating water piping unions, flanges, strainers 2 inch and smaller, heating water piping flexible connectors and expansion joints 2 inches and smaller.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements. Where more than one material is indicated for a particular service, choice of listed material is installer's option, unless otherwise specifically indicated.
- C. Note that all chilled water, heating water, steam, and condensate piping within air handling units shall be fully insulated, including interior sections where piping is installed in the airstream.

Retain portions below only relevant to the project.

- D. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 1 inch thick.
- E. Chilled Water and Brine, 40 Deg F and below:
 - 1. NPS 3/4 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I with vapor retarder and all-service jacket: 1/2 inches thick.
 - 2. NPS 1 to NPS 6: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I with vapor retarder and all-service jacket: 1 inch thick.
 - 3. NPS 8 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, Pipe and Tank Insulation, with vapor retarder and all-service jacket: 1-1/2 inches thick.
- F. Chilled Water and Brine, above 40 Deg F:
 - 1. NPS 3/4 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I with vapor retarder and all-service jacket: 1/2 inches thick.
 - 2. NPS 1 to NPS 6: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I with vapor retarder and all-service jacket: 1 inch thick.

3. NPS 8 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, Pipe and Tank Insulation, with vapor retarder and all-service jacket: 1 inches thick.

G. Makeup Water Piping, 35 to 60 Deg F:

1. NPS 3/4 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I with vapor retarder and all-service jacket: 1/2 inches thick.
2. NPS 1 to NPS 6: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I with vapor retarder and all-service jacket: 1 inch thick.

Indoor condenser water is typically not required to be insulated unless temperatures are operated below 60 Deg F.

H. Condenser-Water Supply and Return, 50 to 105 Deg F:

1. NPS 12 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.
2. NPS 14 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or Pipe and Tank Insulation, with vapor retarder and all-service jacket: 1-1/2 inches thick.

I. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, with all-service jacket: 1-1/2 inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, with all-service jacket: 2 inches thick.

J. Heating-Hot-Water Supply and Return, 200 to 250 Deg F:

1. NPS 3 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, with all-service jacket: 2-1/2 inch thick.
2. NPS 4 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, with all-service jacket: 3 inches thick.

K. Heating-Hot-Water Supply and Return, above 250 Deg F up to 350 Deg F:

1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 3 inches thick.
2. NPS 1-1/4: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 4 inches thick.
3. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 4.5 inches thick.

L. Low Pressure Steam and Steam Condensate, 250 Deg F and Below:

1. NPS 3 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 2.5 inches thick.
2. NPS 4 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 3 inches thick.

M. Medium Pressure Steam and Steam Condensate, less than 350 Deg F:

1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 3 inches thick.
2. NPS 1-1/4: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 4 inches thick.
3. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 4.5 inches thick.

N. High Pressure Steam and Steam Condensate, above 350 Deg F:

1. NPS 3/4 and Smaller: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 4 inches thick.
- 2. NPS 1 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II or Pipe and Tank Insulation, with all-service jacket: 5 inches thick.
- O. Refrigerant Suction and Hot-Gas Piping and Flexible Tubing, 35 to 120 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 1 inch thick.

Refrigerant liquid piping is not always required to be insulated. Mitsubishi mini-split systems requires liquid piping to be insulated. Coordinate with manufacturer requirements.

- P. Refrigerant Liquid Piping and Tubing:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 1 inch thick.
- Q. Dual-Service Heating and Cooling, 40 to 200 Deg F:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, with vapor retarder and all-service jacket: 1-1/2 inches thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, with vapor retarder and all-service jacket: 2 inches thick.
- R. Heat-Recovery Piping, 40 to 140 Deg F:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, with vapor retarder and all-service jacket: 1 inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I, with vapor retarder and all-service jacket: 1-1/2 inches thick.
- S. Boiler Feedwater Piping, 250 Deg F and below: Insulation shall be the following:

1. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 2-1/2 inches thick.

Select from the options below that are relevant to the project.

- T. Flash Steam Piping, from [blowdown separator] [deaerator tank] [hot condensate drain cooler] [safety relief valve] [and] [drip pan elbow], up to 250 Deg F: Insulation shall be the following:

1. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 3 inches thick.

- U. Flash Steam Piping, from [blowdown separator] [deaerator tank] [hot condensate drain cooler] [safety relief valve] [and] [drip pan elbow], greater than 250 Deg F: Insulation shall be the following:

1. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 4 inches thick.

- V. Hot Overflow Piping, from Deaerator Tank: Insulation shall be the following:

1. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 3 inches thick.

Select from the options below that are relevant to the project.

- W. Hot Drain Piping, from [boiler blowdown] [blowdown separator] [and] [deaerator tank], up to 250 Deg F: Insulation shall be the following:

1. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 3 inches thick.

- X. Hot Drain Piping, from [boiler blowdown] [blowdown separator] [and] [deaerator tank], greater than 250 Deg F: Insulation shall be the following:

1. Mineral-Fiber, Preformed Pipe, Type I or II, with all-service jacket: 4 inches thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Piping installed within crawl-spaces underneath occupied areas also applies to this section.
- B. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- C. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements. Where more than one material is indicated for a particular service, choice of listed material is installer's option, unless otherwise specifically indicated.

Retain portions below only relevant to the project. Edit jacketing requirements for outdoor piping in Section 3.15.

- D. Chilled Water and Brine, 30 to 75 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 2 inches thick.

- E. Makeup Water Piping, 35 to 60 Deg F:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 2 inches thick.
- F. Condenser-Water Supply and Return, 50 to 105 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 2 inches thick.
- G. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with all-service jacket: 2-1/2 inches thick.
- H. Heating-Hot-Water Supply and Return, above 200 Deg F to 250 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II, with all-service jacket: 3 inches thick.
- I. Heating-Hot-Water Supply and Return, above 250 Deg F to 350 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II, with all-service jacket: 4 inches thick.
- J. Low Pressure Steam and Steam Condensate, 250 Deg F and Below:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II, with all-service jacket: 3 inches thick.
- K. Medium and High Pressure Steam and Steam Condensate, greater than 250 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II, with all-service jacket: 4 inches thick.

Edit below. KSU Standard is for PVC jacket on exposed refrigerant piping insulation.

- L. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:

- a. Flexible Elastomeric: 3/4 inches thick with [two coats manufacturer's white exterior protective finish] [PVC jacket].
- M. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inches thick with [two coats manufacturer's white exterior protective finish] [PVC jacket].
- N. Heat-Recovery Piping, 40 to 140 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 2 inches thick.
- O. Dual-Service Heating and Cooling:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 2-1/2 inches thick.
- P. Fuel Oil Piping, Heated:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I, with vapor retarder and all-service jacket: 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

Edit special jacket requirements for piping here and on drawings including which services. Typically not required in most cases.

- C. Piping, Concealed:
 - 1. None.
 - 2. PVC: 20 mils thick.
 - 3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
 - 4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
 - 5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.
- D. Piping, Exposed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] thick.
5. Stainless Steel, [Type 304] [or] [Type 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] thick.

E. Piping within Air Handling Units:

1. PVC: 20 mils thick for chilled water and cold services.
2. Aluminum, Smooth: 0.016 inch thick for heating water or steam piping.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

Edit jacket requirements for piping here and on drawings including which services.

C. Piping, Concealed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: 0.016 inch thick.
5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: 0.010 inch thick.

D. Piping, Exposed:

1. PVC: 20 mils 30 mils thick.
2. [Painted] Aluminum, [Smooth] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: 0.016 inch thick.
3. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: 0.010 inch thick.

RETAIN BELOW WHERE APPLICABLE. NOTE: UTILIZE REMOVABLE/REUSABLE INSULATION COVERS IN LIEU OF THE STANDARD SPECIFIED INSULATION FOR THE FOLLOWING. COORDINATE LIMITS OF SIZES TO INSTALL COVERS WITH OWNER.

3.16 MINERAL WOOL REMOVABLE / REUSABLE INSULATION COVERS

Review sizes with client as to sizes to be insulated. Verify in field that these items have been insulated with removable re-usable jackets as this is commonly missed.

- A. Install mineral wool removable / reusable insulation covers on the following:

1. All strainers, expansion joints, regulating valves, control valves, and steam traps on steam 15 psig and under.
 - a. All sizes.
 - b. On sizes 2-1/2 inches and larger only.
2. All strainers, expansion joints, regulating valves, control valves and steam traps on steam over 15 psig.
 - a. All sizes.
 - b. On sizes 2-1/2 inches and larger only.
3. All piping and valving between end shut off valves at Pressure Reducing Station (including shut-off valves).

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Jacketing Requirements
 1. Pipe insulation exposed within reach of the public (within 8' vertical height from floor) or in food service areas shall be covered with 0.5mm thick PVC covers. Johns Manville Zeston, Ceel-Co or equivalent.
 2. Any location exposed to weather (or rain via tunnel entrance), fluids (blow-downs or strainer discharge), maintenance abuse (within 8' vertical height from floor) shall be protected by a suitable jacket system (PVC jacket or aluminum jacket to a weather proof condition). This includes piping within mechanical rooms.
 3. Flexible elastomeric insulation exposed to the outdoors shall be protected with a PVC jacket.
- C. All major steam valves shall be insulated with removable insulation covers (wire connections only).
- D. Insulate steam relief piping located 8'-0" or below or as needed for personnel protection. Provide signage indicating high temperature and possible danger associated with the pipe near termination point.
- E. Low VOC to meet LEED requirements shall be required in all installations.

END OF SECTION 230719

KSU DESIGNERS NOTES:

1. The following mechanical piping systems shall be insulated (minimum thickness shall be reviewed with OUA engineers based on application and design needs):
 - a. Chilled water piping including all valves, sensing lines and tubing, shall be insulated to eliminate condensation.
 - b. A/C condensate lines if install in unconditioned location
 - c. Heating water piping.
 - d. Dual temperature heating and cooling piping.
 - e. Steam piping.
 - f. Steam condensate piping.
 - g. Refrigerant piping (hot gas, suction and liquid). Refrigerant lines outside of building shall be designed with UV protection. (PVC jacket, mastic coating with white finish including a protective all weather jacket.)
 - h. System make-up water piping, backflow, and meters shall be insulated in such a manner as to provide access to test ports and readers.
 - i. Air conditioning condensate drain piping located in interior or penthouse areas where surfaces could be subject to condensing.
 - j. Other piping systems and equipment as directed by OUA.
 - k. Expansion Joints: Removable jackets.
 - l. Steam Control Valves: Pressure reducing valves, humidifier canisters and steam traps – removable jackets.
 - m. Steam Traps 50 psi or greater – removable jackets.
 - n. Steam shut-off valves – insulate flanges and body with standard insulation similar to piping – allow for operation or actuator.
2. Pipe insulation subject to water damage shall be covered with PVC or aluminum jacketing so insulation that may be subject to discharge from strainers, relief valves, automatic air vents or other drain taps is protected with the correct type of jacketing material based on type of discharge exposure.
3. Fiberglass Pipe Insulation
 - a. Encase exterior fiberglass piping insulation with aluminum jacket or PVC wrap with weatherproof construction. Insulation and jacketing systems specifically designed for outdoor or otherwise hazardous locations may be considered. Review with OUA.
 - b. Pipe insulation exposed to blow down, strainer discharge or rain via tunnel entrance shall be covered with PVC jacket or aluminum jacket to a weather proof condition.
4. All insulation thicknesses and densities shall be selected to meet or exceed the energy reductions of current House Bill 251 and ASHRAE 90.1 and utilize ecologically friendly technology when possible. Review with the OUA.

5. Engineer to verify in field during construction that mineral wool removable reusable covers were installed as specified. **THIS IS A COMMONLY MISSED ITEM.**
6. Flexible unicellular insulation may be used on refrigerant piping. Other piping systems may utilize flexible unicellular insulation if approved by OUA.
7. Cellular glass or mineral wool pipe insulation shall be used to insulate steam and steam condensate piping in areas subject to moisture or water damage such as pits and vaults.
8. Cellular glass or mineral piping insulation may be used for direct buried steam piping provided the proper wrap is used to protect the piping and insulation, such as "Gilsulate" or other pre-approved piping system.
9. Calcium Silicate Pipe Insulation: Consult with OUA for special requirements.
10. Vermiculite or Gilsulate Buried Pipe Insulation: Consult with OUA for special requirements and detailing.

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Joining materials.
4. Dielectric fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 1. Pipe.
 2. Fittings.
 3. Joining materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Suspended ceiling components.
 2. Other building services.
 3. Structural members.
- B. Qualification Data: For Installer.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Preconstruction Test Reports:
 1. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 100 psig at 180 deg F.
2. Chilled-Water Piping: 150 psig at 73 deg F.
3. Dual-Temperature Heating and Cooling Water Piping: 100 psig at 180 deg F.
4. Condenser-Water Piping: 150 psig at 73 deg F.
5. Glycol Cooling-Water Piping: 150 psig at 150 deg F.
6. Makeup-Water Piping: 80 psig at 73 deg F.
7. Condensate-Drain Piping: 150 deg F.
8. Blowdown-Drain Piping: 200 deg F.
9. Air-Vent Piping: 200 deg F.
10. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L or M.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Star Pipe Products.
 - c. Victaulic Company.
2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
3. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

E. Copper or Bronze Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mueller Industries, Inc.
 - b. NIBCO INC.
 - c. Viega LLC.
2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.

F. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Grinnell G-Fire by Johnson Controls Company.
 - c. Victaulic Company.
2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile- or malleable-iron housing and **EPDM or nitrile** gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings. Gaskets shall be rated 230 deg F or higher. Mechanical coupling bolts shall be heat treated carbon steel track head conforming to physical properties of ASTM A-183, minimum tensile strength 110,000 psi.

I. Steel Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Victaulic Company.
 - b. Viega LLC.
2. Housing: Steel.
3. O-Rings and Pipe Stop: EPDM.
4. Tools: Manufacturer's special tool.
5. Minimum 300-psig working-pressure rating at 230 deg F.

J. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

- b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Fittings to be constructed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.
- B. Dielectric Unions:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric Nipples:
 - 1. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
 2. Schedule 40, Grade B steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
 4. Schedule 40 steel pipe, pressure-sealed joints.
- C. Hot-water heating piping installed belowground and within slabs shall be the following:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
- D. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
 2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- E. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
 4. Schedule 40 steel pipe, pressure-seal joints.
- F. Chilled-water piping installed belowground and within slabs shall be the following:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

Coordinate piping types for Dual Temperature Systems with KSU OUA. Will be project dependent

- G. Dual-temperature heating and cooling water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
 2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- H. Dual-temperature heating and cooling water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
 4. Schedule 40 steel pipe, pressure-sealed joints.
- I. Dual-temperature heating and cooling water piping installed belowground and within slabs shall be the following:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

Coordinate piping types for Condenser Water piping with KSU OUA. Will be project dependent.

- J. Condenser-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
 2. [Schedule 80] [Schedule 40] steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
 3. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.
- K. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. [Schedule 80] [Schedule 40] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 3. [Schedule 80] [Schedule 40] steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
 4. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.
 5. RTRP and RTRF with adhesive or flanged joints.
- L. Condenser-water piping installed belowground and within slabs shall be either of the following:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
 2. RTRP and RTRF with adhesive or flanged joints.
- M. Glycol cooling-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
 3. Schedule 40 steel pipe; Pressure-sealed joints.
- N. Glycol cooling-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- O. Glycol cooling-water piping installed belowground and within slabs shall be the following:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
- P. Makeup-water piping installed aboveground shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- Q. Makeup-Water Piping Installed Belowground and within Slabs:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
- R. Condensate-Drain Piping:
1. Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- S. Blowdown-Drain Piping:
1. Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- T. Air-Vent Piping:
1. Inlet: Same as service where installed.
 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- U. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.
- 3.2 PIPING INSTALLATIONS
- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

- B. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations (in walls, pipe chases, utility spaces, above ceilings, below grade or floors) unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap. Drain valves shall be provided at all low points, trapped sections, and on the equipment side of all branch valves to permit draining of all parts and all liquid piping systems. Furnish and install drain valves at the base of all new chilled and heating water risers. Drain piping shall be provided from pump glands, relief valves, etc., to spill at the floor over floor drains or other acceptable discharge points. The drain line shall terminate with plain, unthreaded end.
- N. Install piping at a uniform grade of 0.2 percent upward in direction of flow except as otherwise shown. It must be possible to drain every portion of the piping system.
- O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- P. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- Q. Anchor piping to ensure proper direction of expansion and contraction.
- R. All piping shall be installed with a pitch in the direction of flow of not less than one inch in forty feet, except as otherwise shown. It must be possible to drain every portion of the piping system.

SELECT WHO HAS THE AUTHORITY TO MAKE CHANGES

- S. Run lines as direct as possible avoiding unnecessary offsets. However, if offsets are required in order to obtain maximum headroom or to avoid conflict with other work, they shall be made as required or as requested by the [Architect] [Engineer] without additional cost to the Owner. The [Architect][Engineer] reserves the right to make minor changes in the location of piping and equipment during the roughing-in, without additional cost to the Owner. All changes proposed by others shall be approved by the [Architect] [Engineer].
- T. Lines shall be cut accurately to measurement at the site and worked into place without springing or forcing. Sufficient offsets, pipe loops or expansion joints between anchor points shall be provided as needed, whether or not shown, to limit stresses and control movement of lines subject to thermal expansion.
- U. Before any piping is installed, it shall be up-ended and pounded to remove any foreign matter present, and shall be swabbed, if necessary, for thorough cleaning. After installation and before final connections are made, all piping systems shall be flushed with a material that is not injurious to either pipe or equipment.
- V. Taps (half couplings or tees) shall be provided as necessary to permit the installation of temperature control instruments, thermometers, pressure gages, air vents, etc.
- W. Air vents shall be provided at all high points, trapped sections and on equipment connections where indicated. Note: Air vents are typically not indicated on drawings since high points cannot always be determined. This Contractor shall determine high points during construction and vent accordingly.
- X. Any piping resting on or coming in contact with building structure shall be insulated at that point to prevent telegraphing of sound.
- Y. Install valves according to the following:
 - 1. Section 230523 "General Duty Valves and Strainers."
- Z. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- AA. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- BB. Install shutoff valve immediately upstream of each dielectric fitting.

ONLY INCLUDE REFERENCES BELOW PERTAINING TO THE PROJECT

- CC. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- DD. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

- EE. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- FF. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- GG. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Connections between copper and ferrous materials shall be made as follows:
 - 1. For stationary non-rotating, non-vibrating equipment connections shall be made with dielectric unions.
 - 2. For rotating or vibrating equipment connections shall be made with cast brass adapter and bronze flanges with dielectric separation of flanges and bolts.
 - 3. Connections between copper ferrous equipment flanges shall be made using bronze companion flange with dielectric separation of flanges and bolts.
 - 4. Brass or bronze valves separating copper and ferrous materials will not require dielectric separation.
- C. Dielectric Separation of Copper Piping and Building Elements:
 - 1. Isolate copper piping from metal building elements such as steel studs, pipe sleeves, beams, joists, and metal deck with plastic grommets or vinyl tape.
- D. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- E. Dielectric Fittings for NPS 2-1/2 and above: Use dielectric flanges.
- F. Dielectric Nipples for joining dissimilar metals.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32. Remove leftover flux after soldering joints.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
 - 1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
 - 2. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
 - 3. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.
 - 4. Heat joints to proper and uniform temperature.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Align threads at point of assembly.
 - 2. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 3. Assemble joint to appropriate thread depth. When using a wrench on valves, place the wrench on the valve end into which the pipe is being threaded.
 - 4. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. The edges of pipe to be welded shall be machine beveled wherever possible. Before welding, the surfaces shall be thoroughly cleaned. The piping shall be carefully aligned. No metal shall project within the pipe. Mitered joints are prohibited. Only factory formed fittings shall be used. Elbows shall be long radius type. Flanges shall be welding neck type. Mitering of the pipe to form elbows or the notching of straight runs to form tee connections will not be permitted. Weld couplings, threaded or welded branch, are permitted only when branches are four or more sizes smaller than main.
 - 2. Minor leaks in welded joints shall be corrected by chipping out the weld and rewelding. A general sweating of a weld joint will be considered sufficient cause for rejection. Defects that may develop in screwed joints under test shall be corrected by replacing the fitting or thread or both. Caulking of defective threaded joints will not be permitted.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

- H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 AIR VENT VALVES

- A. Manual Vent Valves Within Enclosures: Install manual vent valves on equipment within enclosures where detailed on drawings and elsewhere where equipment air vent connections are furnished within enclosures.
- B. Manual Vent Valves on Piping: Install manual vent valves on piping as indicated in piping section.
- C. Automatic Vent Valves: Install automatic vent valves as indicated. Install shutoff valve between piping or equipment and vent valve, pipe outlet to suitable plumbing drain, if indicated.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.

3.8 FIELD QUALITY CONTROL

- A. All hydrostatic and/or air tests shall be made before piping is concealed or covered. This Contractor shall be responsible for completely draining the systems after hydrostatic tests are performed. Any damage from freezing prior to acceptance of the completed installation shall be repaired at the sole expense of this Contractor.
- B. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- C. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

D. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Kent State Requirements:
 1. Draining or Chemical Cleaning of any Closed Loop Chilled Water, Steam and Steam Condensate Systems, Glycol Systems, Closed Loop Heating Water, and Cooling Tower Water Systems to the City of Kent's sanitary system is prohibited, without filling for a discharge drainage permit. Mandatory two week notice to dump will be required with an approved signed document from the City of Kent. (KSU will not sign for this service) KSU would prefer that the designing engineers require reclaim methods be implemented vs dumping unless no other options are possible. Compliance with these requirements will be required in your base of design for any project on the Kent Campus.
 2. All Hydronic and fire systems shall include in design initial fill and flushing taps for quick fill and flushing of system. Review flush and fill tap locations with OUA engineers.

3. Drain valves (see section on valves) shall be installed on all low points in the piping and manual air vents shall be installed on all high points of the system. All drain valves to be full port design and have 3/4" threaded hose connections with hose cap and chain.
4. Provide adequate fittings to allow flushing and chemical pre-treatment of the entire piping system after initial installation.
5. There shall be no pro-press or grooved piping connections in concealed spaces, above rigid ceilings or in concealed chases or shafts. This type of fitting can only be installed in accessible locations or above a lay-in ceiling. All piping within electrical or tele/data rooms shall be soldered, brazed or welded.
6. All fittings and piping associated with sample ports, pressure gauge, etc. shall be Schedule 80 regardless of system.

END OF SECTION 232113

KSU DESIGNERS NOTES:

1. There shall be no pro-press or grooved piping connections in concealed spaces, above rigid ceilings or in concealed chases or shafts. This type of fitting can only be installed in accessible locations or above a lay-in ceiling. Do not install this type of fittings above 2-1/2" diameter without authorization from the OUA. All piping within mechanical, electrical or tele/data shall be soldered, brazed or welded. Screwed or flanged shall be reviewed with OUA.
2. Check other material types with KSU OUA including T-Drill, Uponor PEX, and Niron. No Mega-Press fittings will be acceptable. Grooved piping may not be acceptable on Condenser Water piping, may require sizes 14" and above to be fully welded or flanged.
3. Associate's design shall be verified by Manufacturer and engineered by associate for all Expansion Joints designs including, Guides and Anchors. CxA shall ensure spacing between Guides, Anchors and Joint and means of attachment to structure meets details. Associates shall indicate and provide installation details and shall review the Installation and Design with KSU-OUA engineers. No 100% delegated design will be acceptable to KSU.
4. All hydronic heating water or chilled water minimum piping distribution size shall be 3/4" nominal pipe diameter. Any smaller line size shall be reviewed on a case by case basis and have written authorization to reduce pipe size below 3/4".
5. The first choice for piping material for heating water and dual temperature water is copper. The Associate shall review the maximum size of piping and maintain all copper if the largest pipe size is 2 1/2" or possibly even 3". KSU allows Pro-Press fittings on copper systems only. See limitations of use on Pro-Press fittings.
6. Manual air vent or automatic air vent with ball isolation valve, with extended drain to non-damaging locations shall be installed on all closed systems. Fill systems shall include reduced pressure backflow devices. System to include pressure gauge downstream of fill valves and tagged with final system pressure setting.
7. Non-ferrous piping is preferred for all condenser water piping and other piping which is drained annually.

- 8. Chemline or approved equal for chilled water. Associate shall review selection of these with OUA.**
- 9. Consideration shall be given to future alteration and expansion of the system i.e. over-sizing lines or providing capped branches for future connections.**
- 10. Associates shall evaluate each Hydronic system design for thermal mass of system to establish if bladder systems, storage tanks and if volume within the system is sufficient to eliminate short cycling of systems and allows for proper bypass and control of the Delta T and P of the system being designed. Provide system flow calculations and diagrams as part of the design process.**

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Hydronic specialty valves.
2. Air-control devices.
3. Flexible Connectors

- B. Related Requirements:

1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
2. Section 230523 "General Duty Valves and Strainers" for specification and installation requirements for valves common to most piping systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett; a Xylem brand.
 - b. Flow Design, Inc.
 - c. Griswold Controls.
 - d. Hays Fluid Controls.
 - e. Nexus Valve, Inc.
- 2. Body: One piece, bronze, ball or y-pattern globe type with venturi. Ball type valves shall include large diameter plated ball, Teflon seats, blow out proof stem with Teflon packing and packing nut, and full size handle. "Y" pattern globe types shall include maintenance free O-ring, and calibrated direct reading of flow on valve stem arrangement.
- 3. Ball: Brass or stainless steel.
- 4. Plug: Resin.
- 5. Seat: PTFE.
- 6. End Connections: Threaded for 2" and smaller.
- 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
- 8. Handle Style: Lever, with infinite memory stop to retain set position.
- 9. Accuracy: Minimum measuring accuracy of +/- 7% within the normal setting range of the valve
- 10. Operating Range: Shall be sized to perform in a normal operation range between 25% and 100% of the full open position, at a minimum pressure differential between 1 and 3 ft. WG, but in no case shall be more than one size smaller than the indicated connecting pipe size.
- 11. Shutoff: All balance valves shall provide 100% positive, dead end leakproof shutoff against the same fluid temperature and pressure ratings as the body.
- 12. Rating: Minimum body ratings are 235 psi at 300 deg. F.
- 13. Maximum Operating Temperature: 250 deg F.

B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Bell & Gossett; a Xylem brand.
 - b. Flow Design, Inc.
 - c. Griswold Controls.
 - d. Hays Fluid Controls.
 - e. Nexus Valve, Inc.
 2. Body: One piece cast-iron or steel body, ball, butterfly, or globe pattern with calibrated orifice or venturi. "Y" pattern globe types shall include maintenance free O-ring, and calibrated direct reading of flow on valve stem arrangement.
 3. All wetted parts shall be alloyed to resist dezincification.
 4. No dielectric fittings shall be required for installation.
 5. Flow Element: "Y" pattern globe type with a minimum measuring accuracy of +/- 7% within the normal setting range of the valve, equipped with dual integral self-sealing differential pressure test ports and caps.
 6. Ball: Brass or stainless steel.
 7. Stem Seals: EPDM O-rings.
 8. Disc: Glass and carbon-filled PTFE.
 9. Seat: PTFE.
 10. End Connections: Flanged or grooved.
 11. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 12. Handle Style: Lever, with infinite memory stop to retain set position.
 13. Accuracy: Minimum measuring accuracy of +/- 7% within the normal setting range of the valve.
 14. Operating Range: Shall be sized to perform in a normal operation range between 25% and 100% of the full open position, at a minimum pressure differential between 1 and 3 ft. WG, but in no case shall be more than one size smaller than the indicated connecting pipe size.
 15. Shutoff: All balance valves shall provide 100% positive, dead end leakproof shutoff against the same fluid temperature and pressure ratings as the body.
 16. Rating: Minimum body ratings are 235 psi at 300 deg. F.
 17. Maximum Operating Temperature: 250 deg F.
- C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. Spence Engineering Company, Inc.
 - e. WATTS.
 2. Body: Bronze or brass.
 3. Disc: Glass and carbon-filled PTFE.
 4. Seat: Brass.
 5. Stem Seals: EPDM O-rings.
 6. Diaphragm: EPT.
 7. Low inlet-pressure check valve.
 8. Valve Seat and Stem: Noncorrosive.
 9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

D. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. Spence Engineering Company, Inc.
 - e. WATTS.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BELIMO Holding AG
 - b. Bray International, Inc.
 - c. Flow Design, Inc.
 - d. Griswold Controls.
 - e. Hays Fluid Controls.
 - f. Nexus Valve, Inc.
2. Body: Brass or ferrous metal.
3. Flow Control Assembly, provide either of the following:
 - a. Piston and Spring Assembly: Stainless steel or Corrosion resistant, tamper proof, self-cleaning, and removable.
 - b. Elastomeric Diaphragm and Polyphenylsulfone Orifice Plate: Operating ranges within 2- to 80-psig differential pressure.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow within plus or minus 5 percent, regardless of system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 250 deg F.

F. Suction Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Products, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. TACO Comfort Solutions, Inc.
2. Angle pattern.
3. 175-psig pressure rating at 250°F, ductile-iron body and end cap, pump-inlet fitting.
4. Bronze startup and bronze and stainless-steel permanent strainers.
5. Bronze or stainless-steel straightening vanes.
6. Threaded or flanged for 2" and smaller, flanged for 2-1/2" and larger.
7. Provide permanent strainer with 3/16" diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head. Provide disposable fine 16 mesh strainer to fit over cylinder strainer.
8. Provide blowdown tapping in bottom with drain plug, gage tapping in side.
9. Furnish both start-up and permanent strainers.
10. Factory-fabricated support to carry weight of suction piping.

G. Triple-Duty Valve:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Products, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. Mueller Steam Specialty Co.
 - e. TACO Comfort Solutions, Inc.
2. Provide flanged cast-iron valve body, pressure rated for 175 psi, maximum operating temperature of 250 deg F.
3. Angle or straight pattern.
4. Ductile-iron body, pump-discharge fitting.
5. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
6. Brass gage ports with integral non-slam check valve with spring-loaded disc and orifice for flow measurement.

H. Basket Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Products, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. Mueller Steam Specialty Co.
 - e. TACO Comfort Solutions, Inc.

2. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: 16 mesh bronze startup strainer, and perforated 304 or 316 stainless-steel basket with 50% free area and lift out handle.
 - a. 1/8" perforations up to 2-1/2" size.
 - b. 5/32" diameter perforations for sizes 3" and greater.
5. Basket sizes through 8" to be cylindrical type and sizes above shall be pleated type to minimize pressure drop.
6. Furnish basket mounted magnetic inserts.
7. Furnish with quick opening swing yoke with yoke screws, bottom mounting and support legs, and bottom threaded drain connection.
8. Rating: 200 psi WOG at 75 deg F.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett; a Xylem brand.
 - b. Hoffman Specialty
 - c. Spirax Sarco
 - d. TACO Comfort Solutions, Inc.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett; a Xylem brand.
 - b. Hoffman Specialty
 - c. Spirax Sarco
 - d. TACO Comfort Solutions, Inc.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.

5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type ASME Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. TACO Comfort Solutions, Inc.
2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Pressure gage and drain fitting.
6. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles.
7. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
8. Size: See Schedules on Drawings.

D. Coalescing-Type Air and Dirt Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Spirotherm, Inc.
 - d. TACO Comfort Solutions, Inc.
2. Tank: Fabricated steel tank; ASME constructed and stamped for 125-psig working pressure and 270 deg F maximum operating temperature.
3. Coalescing Medium: Copper or Stainless steel.
4. Air Vent: Threaded to the top of the separator.
5. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
6. Blowdown Connection: Threaded to the bottom of the separator.
7. Size: See Schedules on Drawings.

E. Tangential-Type Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.

- b. Armstrong Products, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. TACO Comfort Solutions, Inc.
- 2. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
 - 3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
 - 4. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
 - 5. Blowdown Connection: Threaded.
 - 6. Size: See Schedules on Drawings.

F. In-Line Air Separators:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Products, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. TACO Comfort Solutions, Inc.
- 2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
- 3. Blowdown Connection: Threaded at bottom.
- 4. Maximum Working Pressure: Up to 175 psig.
- 5. Maximum Operating Temperature: Up to 300 deg F.
- 6. Size: See Schedules on Drawings.

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Flexonics, Inc.
- 2. Keflex, Inc.
- 3. Metraflex Co.
- 4. Twin City Hose.

B. Stainless-Steel Bellow, Flexible Pipe Connectors:

- 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
- 2. End Connections: Threaded or flanged to match equipment connected.
- 3. Performance: Capable of 3/4-inch misalignment.
- 4. CWP Rating: 150 psig.
- 5. Maximum Operating Temperature: 250 deg F.

C. Stainless-Steel Corrugated Bellows, Flexible Pump Connector:

1. Body: Stainless-steel corrugated bellows with control rods.
2. End Connections: Steel flanges. Expansion element shall be joined to flanges by flaring over face or by welding to the flange bore.
3. CWP Rating: 150 psig.
4. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- B. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve outlet and pipe without valves; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure. Install for each make-up water application as indicated, and in accordance with manufacturer's installation instructions. Set pressure to scheduled value.
- D. Basket Strainer and Suction Diffusers – After flushing system with startup strainers, remove and show startup screens to Owner along with debris removed from startup strainers. Coordinate this requirement with Owner and Engineer at least one week prior to removal of startup strainers.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install full port ball valves upstream of all automatic and manual air vents.
- D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- E. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- F. Install tangential air or coalescing air / dirt separator in pump suction. Install blowdown piping with full-port ball valve; extend full size to nearest floor drain.
- G. Expansion Tanks:
 1. Refer to manufacturer's recommendations for installation requirements.
 2. Install tank fittings that are shipped loose.

3. Install expansion tanks on the floor or above the air separator as indicated on the drawings. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
4. Before making any connections to the tank, check the tank air charge. Use an accurate automotive or similar type gauge on the air valve located at tank top. The air charge pressure must be equal to the charge pressure specified for the system.
5. Use manual vent for initial fill to establish proper water level in tank. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements and as recommended by manufacturer.
6. After making sure that the air charge is correct, the pipe connection to the system may now be made with an isolation ball valve.
7. Piping and air elimination devices should be arranged so that air will not be trapped in the tank, above the tank or in the nozzle. Pitch the piping connection up away from the tank and use automatic air vents where necessary.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Drain valves (see section on valves) shall be installed on all low points in the piping and manual air vents shall be installed on all high points of the system. All drain valves to have threaded hose connections with hose cap and chain.
- C. Manual air vent or automatic air vent with ball isolation drain valve to be extended drain to non-damaging locations on all closed systems.
- D. Fill systems shall include reduced pressure backflow devices. System to include pressure gauge downstream of fill valves and tagged with final system pressure setting.
- E. Provide adequate fittings to allow flushing and chemical pre-treatment of the entire piping system after initial installation.
- F. Expansion tanks shall be properly tagged for system set pressure and labeled. Install with pressure gage on tank.
- G. All balance ports shall be extended to past the insulation thickness for use access.
- H. All fittings and piping associated with sample ports, pressure gauge, etc. shall be Schedule 80 regardless of system.

END OF SECTION 232116

KSU DESIGNERS NOTES:

1. Expansion tanks, bladder tanks, buffer tanks, storage tanks approved manufacturers: Amtrol, Inc., Bell & Gossett ITT; Fluid Handling Division, Taco, Inc. Associate shall review selection of these with OUA.
2. Air and Dirt separators, Spirotherm is preferred vendor, other vendors shall be submitted for review by associate and with OUA prior to bidding. Provide full size bypass piping with valve around separators.
3. System volume tanks, bladder tanks, buffer tanks shall be reviewed by all associates and with OUA to ensure the designs account for the proper system volume to keep boiler, chillers, pumps etc from short cycling and for keeping the system stable on low load conditions.
4. Installation of multipurpose valves shall also be supplied with manual isolation valves so check valve in multipurpose valve can be worked on and maintained without draining system. This valve should only be used if design has a space restraint.
5. Installation of multipurpose valves shall also be supplied with manual isolation valves so check valve in multipurpose valve can be worked on and maintained without draining system.
6. Flexible connectors shall be braided Stainless Steel style; neoprene type isolators are not acceptable.
7. Associate's design shall be verified by Manufacturer and engineered by associate for all Expansion Joints designs including, Guides and Anchors. CxA shall ensure spacing between Guides, Anchors and Joint and means of attachment to structure meets details. Associates shall indicate and provide installation details and shall review the Installation and Design with KSU-OUA engineers. No 100% delegated design will be acceptable to KSU.
8. Provide adequate fittings to allow flushing and chemical pre-treatment of the entire piping system after initial installation.
9. Expansion tanks shall be properly tagged for system set pressure and labeled. Air gauge on tank will be required under the designs.
10. Associates shall evaluate each Hydronic system design for thermal mass of system to establish if bladder systems, storage tanks and if volume within the system is sufficient to eliminate short cycling of systems and allows for proper bypass and control of the Delta T and P of the system being designed. Provide system flow calculations and diagrams as part of the design process.

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Close-coupled, end-suction centrifugal pumps.
3. Separately coupled, horizontally mounted, in-line centrifugal pumps.
4. Separately coupled, vertically mounted, in-line centrifugal pumps.
5. Separately coupled, base-mounted, end-suction centrifugal pumps.
6. Separately coupled, base-mounted, double-suction centrifugal pumps.
7. Separately coupled, vertically mounted, double-suction centrifugal pumps.
8. Separately coupled, vertically mounted, turbine centrifugal pumps.
9. Wet-rotor pumps.
10. Automatic condensate pump units.

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities; shipping, in-installed, and operating weights; furnished specialties; final impeller dimensions; and accessories for each type of product indicated. Indicate pump's operating point on curves, showing flow vs. pressure, horsepower, and NPSH. Curves shall be developed sufficiently to indicate overload horsepower throughout the flow range. All pumps shall be non-overloading over the full range of the performance curve at the impeller size selected and motor horsepower provided. Indicate flow curve for maximum impeller size in addition to impeller selected. Submittals for pumps without curves will be rejected.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components. Show pump layout and connections. Include Setting Drawings with templates for in-installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: Submit maintenance data and parts lists for each type of pump, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Divisions 01 and 23.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING:

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with Manufacturer's rigging and installation instructions for unloading HVAC pumps, and moving them to final location.
- F. Handle HVAC pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged HVAC pumps or components; replace with new. Apply manufacturer's touch up paint after installation to leave installed pumps in a like-new condition.

1.7 COORDINATION:

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 230050 "Basic Mechanical Materials and Methods".

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

Similar to TACO model 1900 or KV.

NOTE the 1900 and KV Series is self supported by the piping and can be installed horizontally or vertically.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aurora Pump; Pentair Ltd.
 2. Armstrong Pumps, Inc.
 3. Bell and Gossett, ITT.
 4. Patterson Pump Company; a Gorman-Rupp company.
 5. Peerless Pump Company.
 6. TACO Comfort Solutions, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
- C. Capacities and Characteristics: See Schedules on Drawings.
- D. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, companion-flange connections.
 2. Impeller: ASTM B 584, cast bronze or stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
 3. Pump Shaft: Steel, with copper-alloy or bronze shaft sleeve.
 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
 5. Pump Bearings: Permanently lubricated ball bearings.
- E. Motor: Single speed and rigidly mounted to pump casing.

2.2 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

Similar to TACO model CI

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aurora Pump; Pentair Ltd.
 2. Bell and Gossett, ITT
 3. PACO Pumps; Grundfos Pumps Corporation, USA.
 4. Patterson Pump Company; a Gorman-Rupp company.
 5. Peerless Pump Company.
 6. TACO Comfort Solutions, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.
- C. Capacities and Characteristics: See Schedules on Drawings.
- D. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.
2. Impeller: ASTM B 584, cast bronze or stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

E. Motor: Single speed and rigidly mounted to pump casing with integral pump support.

2.3 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

Similar to TACO model 1600; TACO standard motor is ODP for this model- PUMP MUST BE MOUNTED WITH MOTOR IN THE HORIZONTAL POSITION.

1. Aurora Pump; Pentair Ltd.
2. Armstrong Pumps, Inc.
3. Bell and Gossett, ITT.
4. Patterson Pump Company; a Gorman-Rupp company.
5. Peerless Pump Company.
6. TACO Comfort Solutions, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

C. Capacities and Characteristics: See Schedules on Drawings.

D. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze or stainless steel; statically and dynamically balanced, and keyed to shaft. For pumps not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

E. Shaft Coupling: Molded-rubber insert with interlocking spider capable of absorbing vibration.

F. Motor: Single speed and resiliently mounted to pump casing.

2.4 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

Similar to TACO model KS; TACO standard motor is Totally enclosed, fan cooled for this model.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Bell and Gossett, ITT
 - 3. TACO Comfort Solutions, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.
- C. Capacities and Characteristics: See Schedules on Drawings.
- D. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
 - 2. Impeller: ASTM B 584, cast bronze or stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
 - 3. Pump Shaft: Stainless steel.
 - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
 - 5. Pump Bearings: Permanently lubricated ball bearings.
- E. Shaft Coupling: Axially split spacer coupling.
- F. Motor: Single speed and rigidly mounted to pump casing with lifting eyebolt and supporting lugs in motor enclosure.

2.5 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

Similar to TACO model FI. TACO standard motor is Totally enclosed, fan cooled for this model.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Aurora Pump; Pentair Ltd.
 - 3. Bell and Gossett, ITT
 - 4. PACO Pumps; Grundfos Pumps Corporation, USA.
 - 5. Patterson Pump Company; a Gorman-Rupp company.
 - 6. Peerless Pump Company.
 - 7. TACO Comfort Solutions, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

- C. Capacities and Characteristics: See Schedules on Drawings.
- D. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
 - 2. Impeller: ASTM B 584, cast bronze or stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
 - 3. Pump Shaft: Stainless steel.
 - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket.
 - 5. Pump Bearings: Permanently lubricated ball bearings.
- E. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. Provide EPDM coupling sleeve or other suitable material for variable-speed applications.
- F. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- G. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor. Include built-in drain pan with drain coupling, and access to permit grouting.
- H. Motor: Single speed, secured to mounting frame, with adjustable alignment.

2.6 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

Similar to TACO model TA. TACO standard motor is Totally enclosed, fan cooled for this model.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Aurora Pump; Pentair Ltd.
 - 3. Bell and Gossett, ITT
 - 4. PACO Pumps; Grundfos Pumps Corporation, USA.
 - 5. Patterson Pump Company; a Gorman-Rupp company.
 - 6. Peerless Pump Company.
 - 7. TACO Comfort Solutions, Inc.
 - 8. Weil Pump Company
- B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
- C. Capacities and Characteristics: See Schedules on Drawings.

D. Pump Construction:

Select Appropriate Class below

1. Casing: Horizontally split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, [Class 125] [Class 250] flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.
 2. Impeller: ASTM B 584, cast bronze or stainless steel; statically and dynamically balanced, and keyed to shaft.
 3. Pump Shaft: Stainless steel.
 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket.
 5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- E. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve or other suitable material for variable-speed applications.
- F. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- G. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor. . Include built-in drain pan with drain coupling, and access to permit grouting.
- H. Motor: Single speed, secured to mounting frame, with adjustable alignment.

2.7 SEPARATELY COUPLED, VERTICALLY MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

Similar to TACO model TC or TS. TACO standard motor is Totally enclosed, fan cooled for this model.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Pumps, Inc.
 2. Aurora Pump; Pentair Ltd.
 3. Bell and Gossett, ITT
 4. Patterson Pump Company; a Gorman-Rupp company.
 5. Peerless Pump Company.
 6. TACO Comfort Solutions, Inc.
 7. Weil Pump Company
- B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

C. Pump Construction:

Select appropriate pressure class rating

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom of volute, mounting support, and ASME B16.1, [Class 125] [Class 250] flanges.
 2. Impeller: ASTM B 584, cast bronze or stainless steel; statically and dynamically balanced, and keyed to shaft.
 3. Pump Shaft: Stainless steel.
 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket.
 5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration.
- E. Motor: Single speed and secured to casing.

2.8 SEPARATELY COUPLED, VERTICALLY MOUNTED, TURBINE CENTRIFUGAL PUMPS (VT)

Similar to Taco model VT. TACO standard motor is Totally enclosed, fan cooled for this model.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Pumps, Inc.
 2. Aurora Pump; Pentair Ltd.
 3. Bell and Gossett, ITT
 4. Patterson Pump Company; a Gorman-Rupp company.
 5. TACO Comfort Solutions, Inc.
- B. Description: Factory-assembled and -tested, [single-stage] [multistage], centrifugal, impeller-between-bearings, end-suction pump as defined in HI 2.1-2.2 and HI 2.3; designed for installation with pump and motor shafts mounted vertically and projecting into a sump.
- C. Capacities and Characteristics: See Schedules on Drawings.
- D. Pump Construction:
1. Pump Bowl: Cast iron, with basket strainer, replaceable bronze wear ring, and suction bell. Water passages of intermediate bowls shall be coated with porcelain or epoxy enamel.
 2. Impeller: ASTM B 584, cast bronze or stainless steel; statically and dynamically balanced and keyed to shaft.
 3. Pump Shaft: Stainless steel sized according to manufacturer's requirements.
 4. Pump Bearings: Water-lubricated bronze and rubber sleeve bearings in cast-iron housing
 5. Pump Column: ASTM A 53/A 53M, Grade B steel pipe.
 6. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
- E. Shaft Coupling: Keyed with locking collets.

Select appropriate pressure class rating

- F. Discharge Head: ASME B16.1, [Class 125] [Class 250] discharge flange with threaded gage tapping. Top of discharge head shall have a registered fit to accurately locate the driver.
- G. Drive Ratchet: Non-reversing ratchet.
- H. Hollow Shaft Motor: Single speed and secured to discharge head.

2.9 WET-ROTOR PUMPS

Similar to TACO model 00

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Bell and Gossett, ITT
 - 3. TACO Comfort Solutions, Inc.
- B. Description: Factory-assembled and -tested, wet-rotor pump.
- C. Pump Construction:
 - 1. Body: Cast iron.
 - 2. Impeller: Non-metallic, Noryl.
 - 3. Pump Shaft: Ceramic.
 - 4. Bearings: Double-sintered carbon.
- D. Motor: Single speed.

2.10 AUTOMATIC CONDENSATE PUMP UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Beckett Corporation.
 - 2. Hartell Pumps; Milton Roy.
 - 3. Little Giant Pump Co.
- B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.
- C. Capacities and Characteristics: See Schedules on Drawings.

2.11 PUMP MOTORS

- A. Motor: Single speed, mounted to pump casing.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Premium Efficient Motors
 - a. Enclosure: Open, Dripproof or Totally Enclosed, Fan Cooled.
 - b. Motor Bearings: Permanently lubricated ball bearings.
 - c. Enclosure Materials: Cast iron, Cast aluminum, or Rolled steel.
 - d. Motor Bearings: Grease lubricated.

Edit below if pump motors are located in unusual conditions

- e. Unusual Service Conditions:
 - 1) Ambient Temperature: <Insert deg C>.
 - 2) Altitude: <Insert feet> above sea level.
 - 3) High humidity.
- f. Efficiency: Premium efficient.

Select appropriate NEMA class below. 1 = normal protection against solid ingress. 2 = protection against solid and water ingress (dripping and light splashing). 3 = indoor or outdoor windblown dirt, dust, snow, rain, sleet. 3R = indoor or outdoor falling dirt, dust, snow, rain, sleet. 4x = indoor or outdoor includes hose directed water. 5 = indoor protect versus falling dirt and settling dust, lint, fibers, and flyings. 6 = indoor or outdoor hose directed water and occasional submersion. 6P = indoor or outdoor hose directed water and prolonged submersion. 12 = indoor protect versus falling dirt and settling dust, lint, fibers, and flyings and ingress of dripping and light splashing water.

Provides a Degree of Protection Against the Following Conditions	Type of Enclosure									
	1 *	2 *	4	4X	5	6	6P	12	12K	13
Access to hazardous parts	X	X	X	X	X	X	X	X	X	X
Ingress of solid foreign objects (falling dirt)	X	X	X	X	X	X	X	X	X	X
Ingress of water (Dripping and light splashing)	...	X	X	X	X	X	X	X	X	X
Ingress of solid foreign objects (Circulating dust, lint, fibers, and flyings **)	X	X	...	X	X	X	X	X
Ingress of solid foreign objects (Settling airborne dust, lint, fibers, and flyings **)	X	X	X	X	X	X	X	X
Ingress of water (Hosedown and splashing water)	X	X	...	X	X	...	...	...
Oil and coolant seepage	X	X	X
Oil or coolant spraying and splashing	X
Corrosive agents	X	...	...	X	...	...	...
Ingress of water (Occasional temporary submersion)	X	X	...	...	...
Ingress of water (Occasional prolonged submersion)	X	...	...	...

* These enclosures may be ventilated.

** These fibers and flyings are nonhazardous materials and are not considered Class III type ignitable fibers or combustible flyings. For Class III type ignitable fibers or combustible flyings see the National Electrical Code, Article 500.

- g. NEMA Design: <Insert designation>.

- h. Service Factor: 1.15.
- i. Shaft Grounding Rings: On all pumps driven by variable frequency drives.

Select below and note on schedule when PC motors are used. Coordinate with pump manufacturer as they vary with respect to offerings and available sizes.

- j. EC Permanent Magnet Motor (EC).
 - 1) Where scheduled provide pump with integral EC motors.

Select below and schedule when VFDs are to be provided either integral or remote by manufacturer. Coordinate with pump manufacturer as they vary with respect to offerings and available sizes.

4. Integral Motors with Variable Speed Drives by Pump Manufacturer:

- a. The self-sensing product shall consist of a factory supplied pump with motor and preprogrammed drive with integral controls package.
- b. VFDs to be provided by the manufacturer and **[mounted directly to pump by manufacturer] [furnished loose for remote installation by contractor]**.
- c. Pumps shall be variable-speed with micro-controlled operation providing BACnet read write technology.
- d. The controller operation shall operate the system using a tested and proven program that safeguards against undesirable or damaging conditions.
- e. All pumps shall be furnished with lockout security feature for field programming.
- f. Provide all maintenance tools or hand held programmable/diagnostic devices that may be required for programming of pump's drive.
- g. Motor and drive assembly shall meet all NEC power requirements and be UL listed.
- h. Refer to Specification Section 232923 Variable Frequency Motor Controllers for additional requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Comply with **[HI 1.4] [and] [HI 2.4]**.

"HI 1.4" option for centrifugal pumps and "HI 2.4" option for vertically mounted, turbine centrifugal pumps

- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- E. Equipment Mounting:
 - 1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in 230050 "Basic Mechanical Materials and Methods".

Select one of the two options below.

- 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and vibration isolation hangers of size required to support weight of in-line pumps.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- G. Pipe base drains and coupling drain to spill into floor drains and route to not obstruct walking patterns and pump access.

3.3 ALIGNMENT

- A. Perform alignment service.
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, valves and specialties.

- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps with reductions at pumps connections as required. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Verify that pumps are installed and connected according to the Contract Documents.
 - 2. Complete installation and startup checks according to manufacturer's written instructions.
 - 3. Check piping connections for tightness.
 - 4. Clean strainers on suction piping.
 - 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 7. Start motor.
 - 8. Open discharge valve slowly.
- B. Pumps found without specified wear rings within warranty period will require complete replacement of pump with new including associated labor and material at no cost to the Owner.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.
- B. Review data in maintenance manuals. Refer to Division 1 and Section 230100.
- C. Schedule training with Owner, through Design Professional, with at least seven days' advance notice.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Flush Lines:
 - 1. All pumps shall have a flushing seal design, or a factory-installed vent/seal flush line to insure removal of trapped air and seal cooling.

Select one of the following two options where pumped fluid may contain solids which could affect seal life.

- 2. Furnish a factory-installed 5 micron filter in the pump flush line.
 - 3. Furnish a factory-installed Kynar cyclone separator in the pump flush line.
- C. Pumps to be provided with flow directional indicators on casing.
- D. All base mounted pumps shall be mounted on a 4" high housekeeping pad as a minimum. All pumps to be grouted after final alignment.
- E. All pumps must be aligned using laser or highest technology available to insure true operation and long life.
- F. Keep all pump openings covered during construction to reduce chance of debris entering the pump casing.

4.2 KENT STATE REQUIREMENTS:

- A. Pumps to be capable of transferring fluids with temperatures from 12°F to 230°F where system medium operates at these temperatures.
- B. Pumps to be designed when applicable to handle up to 50% glycol solution where used in glycol systems.

END OF SECTION 232123

KSU DESIGNERS NOTES:

- 1. KSU Preference is for EC motors wherever feasible.
- 2. Consultants shall make sure that pump installation is never in the horizontal position with motor/drive assembly in the upright position while in a horizontal plane.

3. EC pumps shall have flanged connections and consultants shall specify matching flanges for field installation.
4. Pumps shall be designed for non-overloading conditions and be reviewed with OUA.
5. Pump casing shall be cast iron (class30 or better), internal parts shall be stainless steel. Shaft, O-rings, seals and bearings, shaft-grounding rings shall be reviewed with KSU.

SECTION 232213 - STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes pipe and fittings for LP, MP, and HP steam and condensate piping:
 - 1. Steel pipe and fittings.
 - 2. Joining materials.
- B. Related Requirements:
 - 1. Section 232216 "Steam and Condensate Heating Piping Specialties" for flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Steel pipe and fitting.
 - 2. Joining material.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Other building services.
 - 3. Structural members.
- B. Qualification Data: For Installer.
- C. Welding certificates.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding: Qualify procedures and operators according to the following:
 - 1. ASME Compliance: Comply with ASME B31.1, "Power Piping," and ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
 - 1. HP Steam Piping: 65 psig and above.
 - 2. MP Steam Piping: 16-64 psig.
 - 3. LP Steam Piping: 0-15 psig.
 - 4. HP Condensate Piping: 125 psig at 355 deg F.
 - 5. MP Condensate Piping: 65 psig at 315 deg F.
 - 6. LP Condensate Piping: 15 psig at 250 deg F.
 - 7. Makeup-Water Piping: 80 psig at 150 deg F.
 - 8. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
 - 9. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
 - 10. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in piping applications articles.
- C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.
- D. Malleable-Iron Unions: Hexagonal stock, with ball-and-socket joints, ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

- E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.3 JOINING MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Expert Gasket and Seal LLC.
 - 2. Flexitallic model CGI
 - 3. Mercer Gasket and Shim
- B. Pipe-Flange Gasket Materials: “Metal Spiral Wound” thickness, material, and type suitable for chemical and thermal conditions of piping system contents.
 - a. ASME B16.21, be spiral wound gasket with a carbon steel outer ring, 316L metal winding strip with flexible graphite filler material and 316L inner guide ring Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS (0-15 PSIG)

- A. LP Steam Piping, NPS 2 and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 150 malleable-iron; and threaded joints.

- B. LP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- C. Condensate piping above grade, NPS 2 and smaller: Schedule 80, Type S, Grade B, steel pipe; Class 150 malleable-iron fittings; and threaded joints.
- D. Condensate piping above grade, NPS 2-1/2 and larger: Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- E. Condensate piping below grade, NPS 2 and smaller: Schedule 80, Type S, Grade B, steel pipe; Class 150 wrought-steel fittings; and threaded joints.
- F. Condensate piping below grade, NPS 2-1/2 and larger: Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.2 MP STEAM PIPING APPLICATIONS (16-64 PSIG)

- A. MP Steam Piping, NPS 2 and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 150 malleable-iron; and threaded joints.
- B. MP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- C. MP Steam Piping, NPS 14 through NPS 18: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- D. MP Steam Piping, NPS 20 and Larger: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- E. Condensate piping above grade, NPS 2 and smaller: Schedule 80, Type S, Grade B, steel pipe; Class 150 malleable-iron fittings; and threaded joints.
- F. Condensate piping above grade, NPS 2-1/2 and larger: Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- G. Condensate piping below grade, NPS 2 and smaller: Schedule 80, Type S, Grade B, steel pipe; Class 150 malleable-iron fittings; and threaded joints.
- H. Condensate piping below grade, NPS 2-1/2 and larger: Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.3 HP STEAM PIPING APPLICATIONS (76 PSIG AND ABOVE)

- A. HP Steam Piping, NPS 2 and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 300 cast-iron fittings; and threaded joints.

- B. HP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type E, Grade B, steel pipe; Class 300 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- C. HP Steam Piping, NPS 14 through NPS 18: Schedule 40, Type E, Grade B, steel pipe; Class 300 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- D. HP Steam Piping, NPS 20 and Larger: Schedule 40, Type E, Grade B, steel pipe; Class 300 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- E. Condensate piping above grade, NPS 2 and smaller: Schedule 80, Type S, Grade B, steel pipe; Class 300 cast-iron fittings; and threaded joints.
- F. Condensate piping above grade, NPS 2-1/2 and larger: Schedule 80, Type E, Grade B, steel pipe; Class 300 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- G. Condensate piping below grade, NPS 2 and smaller: Schedule 80, Type S, Grade B, steel pipe; Class 300 cast-iron fittings; and threaded joints.
- H. Condensate piping below grade, NPS 2-1/2 and larger: Schedule 80, Type E, Grade B, steel pipe; Class 300 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.4 ANCILLARY PIPING APPLICATIONS

- A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- B. Vacuum-Breaker Piping: Outlet, same as service where installed.
- C. Safety-Valve-Inlet and -Outlet Piping: Shall match the specification for the pressure rating steam piping (or boiler rating, whichever is higher) upstream of the safety relief valve.
- D. Pumped condensate shall match specifications for low pressure condensate for pump pressures less than 100 psig, and high pressure condensate above 100 psig.
- E. Miscellaneous Vent and Drain Piping: Shall match the specification for the pressure rating of the steam or condensate piping to which it is connected or serves.

3.5 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Locations and arrangements of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- C. Install piping in concealed locations (in walls, pipe chases, utility spaces, above ceilings, below grade or floors) unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Install piping to permit valve servicing.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- M. Install drains at low points in steam condensate mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, rated for pressure of piping and short 3/4" threaded nipple and cap.
- N. Install steam supply piping at a uniform grade of 1/4 inch in ten feet downward in the direction of flow.
- O. Install condensate return piping at a uniform grade of 1/2 inch in ten feet downward in the direction of flow.
- P. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- Q. Install branch connections to supply mains using 45 degree fittings in main with take-off out of the top of the main. Use of 90 degree "tee" fittings is permissible, where use of 45 degree fittings are not practical. Where the length of a branch takeoff is less than 10 feet, pitch branch line down toward mains, 1/2 inch per foot.
- R. Install valves according to the following Sections or other Sections as needed:
 - 1. Section 230523 "General Duty Valves and Strainers."
- S. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- T. Install flanges in piping for valves, apparatus, and equipment, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

- U. Install shutoff valve immediately upstream of each dielectric fitting.
- V. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- W. Anchor piping to ensure proper direction of expansion and contraction. Expansion loops and joints are indicated on the Drawings and specified in Division-23 Section "Expansion Fittings and Loops".
- X. Install drip legs at low points and natural drainage points in the system, such as at the ends of mains, bottoms of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.
 - 1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 200 feet where pipe is pitched down in the direction of the steam flow and a maximum of 150 feet where the pipe is pitched up so that condensate flow is opposite of steam flow.
 - 2. Size drip legs at vertical risers full size and extend beyond the rise. Size drip legs at other locations same diameter as the main. Unless otherwise dimensioned, provide an 18 inch drip leg for steam mains smaller than 6 inches. In steam mains 6 inches and larger, provide drip legs sized 2 pipe sizes smaller than the main, but not less than 4 inches.
 - 3. Drip legs, dirt pockets, and strainer blowdowns shall be equipped with gate valves to allow removal of dirt and scale.
 - 4. Install steam traps close to drip legs.
 - 5. On high pressure steam piping install flexible connectors on high pressure condensate after steam trap.
- Y. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- Z. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- AA. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- BB. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- CC. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 STEAM AND CONDENSATE PIPING SPECIALTIES INSTALLATION

- A. Comply with requirements in Section 232216 "Steam and Condensate Heating Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.7 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for installation of hangers and supports. Comply with requirements below for maximum spacing.
- B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.8 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe with threads which are corroded or damaged. Do not use pipe sections that have cracked or open welds. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
 - 3. Assemble joint to appropriate thread depth. When using a wrench on valves, place the wrench on the valve end into which the pipe is being threaded.
- D. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

3.9 FIELD QUALITY CONTROL

- A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping," and ASME B31.9, "Building Services Piping," and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. Use traps installed at high points in the system to release trapped air while filling the system. Use drip legs installed at low points for complete removal of the test liquid.
 3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
 5. After hydrostatic test pressure has been applied for at least 60 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
- D. Prepare test and inspection reports.

END OF SECTION 232213

KSU DESIGNERS NOTES:

1. Copper piping shall be kept to a minimum in steam and condensate piping systems. Steel Schedule 80 shall be used for condensate piping, Schedule 40 steel for steam distribution.
2. Steam vents, or any safety relief vents shall be designed for thermal expansion thru roof structures and shall be designed for ventilation at building/roof penetrations. Penetration and curb details shall be required in all designs and shall be reviewed with OUA for final approval.

SECTION 232216 - STEAM AND CONDENSATE HEATING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following piping specialties for steam and condensate piping:

1. Flash tanks.
2. Stop-check valves.
3. Safety valves.
4. Pressure-reducing valves.
5. Steam traps.
6. Thermostatic air vents and vacuum breakers.
7. Flexible connectors.

- B. Related Requirements:

1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
2. Section 230523 "General Duty Valves and Strainers" for specification and installation requirements for globe valves common to most piping systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Flash tank.
2. Valve.
3. Steam trap.
4. Air vent and vacuum breaker.
5. Connector.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to the following:
 - 1. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
 - 1. HP Steam Piping: 65 psig and above.
 - 2. MP Steam Piping: 16-64 psig.
 - 3. LP Steam Piping: 0-15 psig.
 - 4. HP Condensate Piping: 125 psig at 355 deg F.
 - 5. MP Condensate Piping: 65 psig at 315 deg F.
 - 6. LP Condensate Piping: 15 psig at 250 deg F.
 - 7. Makeup-Water Piping: 80 psig at 150 deg F.
 - 8. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
 - 9. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
 - 10. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 FLASH TANKS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. MEPCO
 - 2. Spirax Sarco, Inc.
 - 3. Watson McDaniels.
 - 4. Wessels.
- B. Factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code for 150-psig rating, and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.
- C. Construct flash tanks of welded Schedule 80 steel as detailed on the drawings, and in accordance with ASME boiler and pressure vessel code, for 150 psig rating for flash tanks receiving condensate from mains up to 100 psig, and 250 psig rating above. Fabricate all welds and tappings for connections as detailed prior to application of ASME label.

2.3 STOP-CHECK VALVES

A. Stop-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane; Crane Energy Flow Solutions.
 - b. Jenkins Valves.
 - c. Lunkenheimer Valves.
2. Body and Bonnet: Malleable iron.
3. End Connections: Flanged.
4. Disc: Cylindrical with removable liner and machined seat.
5. Stem: Brass alloy.
6. Operator: Outside screw and yoke with cast-iron handwheel.
7. Packing: PTFE-impregnated packing with two-piece packing gland assembly.
8. Pressure Class: 250.

2.4 STEAM SAFETY VALVES

A. Bronze Steam Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Consolidated
 - c. Kunkle Valve.
 - d. Lunkenheimer Co
 - e. Spirax Sarco, Inc.
 - f. WATTS.
 - g. Watson McDaniels.
2. Select steam safety valves for full relief of capacity of equipment served, in accordance with ASME Boiler and Pressure Vessel Code
3. Disc Material: Forged copper alloy.
4. End Connections: Threaded inlet and outlet.
5. Spring: Fully enclosed cadmium-plated or stainless steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
6. Pressure Class: 250.
7. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code. See Schedules on Drawings.

B. Cast-Iron Steam Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Armstrong International, Inc.
 - b. Consolidated
 - c. Kunkle Valve.
 - d. Lunkenheimer Co
 - e. Spirax Sarco, Inc.
 - f. WATTS.
 - g. Watson McDaniels.
- 2. Select steam safety valves for full relief of capacity of equipment served, in accordance with ASME Boiler and Pressure Vessel Code
 - 3. Disc Material: Forged copper alloy with bronze nozzle.
 - 4. End Connections: Raised-face flanged inlet, threaded connections for NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.
 - 5. Spring: Fully enclosed cadmium-plated or stainless steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
 - 6. Pressure Class: 250.
 - 7. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
 - 8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code. See Schedules on Drawings.

2.5 PRESSURE-REDUCING VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Spence Engineering is the only approved manufacturer for KSU.

- 1. Spence Engineering Company, Inc. or equal as approved by KSU OUA.
- B. Capacities and Characteristics: See Schedules on Drawings.
 - C. ASME labeled.
 - D. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
 - E. Description: Pilot-actuated diaphragm type, with adjustable pressure range and positive shutoff.
 - 1. Provide cover over pilot diaphragm for protection against dirt accumulation.
 - 2. Provide pilot valve separate from the main valve, connected to it by unions.
 - 3. Provide a strainer built into the pilot inlet.
 - F. Body: Cast iron or semi-steel body.
 - G. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.
 - H. Trim: Hardened stainless steel.
 - I. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

- J. Performance: Pressure regulating valves shall regulate accurately throughout the range of pressure and flow conditions scheduled. Valves shall function quietly and shall close off tightly on a dead-end shutoff.

2.6 STEAM TRAPS

A. Thermostatic Steam Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Spence Engineering Company, Inc.
 - c. Spirax Sarco, Inc.
 - d. Watson McDaniels
2. Body: Bronze or cast brass angle-pattern body with integral union tailpiece and screw-in cap.
3. Trap Type: Balanced pressure.
4. Bellows: Stainless steel or monel.
5. Head and Seat: Replaceable, hardened stainless steel.
6. Pressure Class: 125.

B. Thermodynamic Steam Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Spence Engineering Company, Inc.
 - c. Spirax Sarco, Inc.
 - d. Watson McDaniels.
2. Body: Stainless steel with screw-in cap.
3. End Connections: Threaded.
4. Disc and Seat: Stainless steel.
5. Maximum Operating Pressure: 600 psig.

C. Float and Thermostatic Steam Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Spence Engineering Company, Inc.
 - c. Spirax Sarco, Inc.
 - d. Watson McDaniels.
2. Body and Bolted Cap: ASTM A 126 cast iron or semi-steel designed so all internal parts are accessible without disturbing piping.

3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel with positive snap-action valve mechanism.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

D. Inverted Bucket Steam Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Only Armstrong approved by KSU OUA for inverted bucket traps.

a. Armstrong International, Inc. (Only)

2. End Connections: Threaded.
3. Head and Seat: Stainless steel.
4. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel operating on knife edges for friction-free performance. All internal parts are to be accessible without disturbing piping.
5. Bucket: Brass or stainless steel.
6. Air Vent: Stainless-steel thermostatic vent.
7. Pressure Rating: 250 psig.

2.7 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Pressure Balanced Thermostatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty.
 - c. Spirax Sarco, Inc.
 - d. Watson McDaniels.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded, 1/2" size.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 250 psig.
7. Maximum Temperature Rating: 450 deg F.

B. Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Eaton Corp.; Controls Div.
 - c. Hoffman Specialty.
 - d. Spirax Sarco, Inc.
 - e. Watson McDaniels.
2. Body: Brass or Stainless steel.
3. End Connections: Threaded, 1/2" size.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-Ring Seal: Ethylene propylene rubber.
6. Pressure Rating: 210 **psig**.
7. Maximum Temperature Rating: 500 **deg F**.

2.8 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hyspan Precision Products, Inc.
 - b. Mason Industries, Inc.
 - c. Metraflex Company (The).
 - d. Twin City Hose, Inc.
2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch misalignment.
5. Maximum Working Pressure: 300 psig.
6. Maximum Operating Temperature: 800 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
- B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 PIPING INSTALLATION

- A. Install piping to permit valve servicing.
- B. Install drains, consisting of a tee fitting, NPS 3/4 full-port ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. Install valves according to Section 230523 "General Duty Valves and Strainers"
- D. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment and elsewhere as indicated.
- E. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full-port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- H. **Flash Tank:**
 - 1. Pitch condensate piping down toward flash tank.
 - 2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
 - 3. Install thermostatic air vent at tank top.
 - 4. Install safety valve at tank top.
 - 5. Install full-port ball valve, and swing check valve on condensate outlet.
 - 6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for 3 times the calculated heat load.
 - 7. Install pressure gage on low-pressure steam outlet according to Section 230519 "Meters and Gages for HVAC Piping."

3.3 STEAM-TRAP INSTALLATION

- A. Install steam traps in accessible locations as close as possible to connected equipment.
- B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.4 PRESSURE-REDUCING VALVE INSTALLATION

- A. Install pressure-reducing valves in accessible location for maintenance and inspection.
- B. Install gate valves on both sides of pressure-reducing valves.
- C. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections, respectively.

- D. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Section 230519 "Meters and Gages for HVAC Piping."
- E. Install strainers upstream for pressure-reducing valve.
- F. Install safety valve downstream from pressure-reducing valve station.

3.5 SAFETY VALVE INSTALLATION

- A. Install safety valves according to ASME B31.1, "Power Piping," and ASME B31.9, "Building Services Piping."
- B. Pipe safety-valve discharge without valves to atmosphere outside the building.
- C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
- D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. All safety steam pressure relief valves to be furnished with drip pan elbows and drains extended to nearest floor drains.

END OF SECTION 232216

KSU DESIGNERS NOTES:

- 1. No "Trip Stop" Safety Relief Valves are to be used.
- 2. Safety relief valves shall be discharged outside and in an area clear of public access.
- 3. Review steam pressure relief valve settings with OUA when used with pressure reducing station. Insulate relief piping located 8'-0" or below or as needed for personnel protection. Provide signage indicating high temperature and possible danger associated with the pipe near termination point.
- 4. Steam vents, or any safety relief vents shall be designed for thermal expansion thru roof structures and shall be designed for ventilation at building/roof penetrations. Penetration and curb details shall be required in all designs and shall be reviewed with OUA for final approval.

5. Receiver Vents Flash Tank Vent: Extend fully outdoors to safe location, roof preferred (review with OUA). Insulate flash tank and vent piping indoors and outdoors for personnel protection.

SECTION 232223 - STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes steam condensate pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include receiver capacity and material.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

Retain only relevant items below

2.1 SINGLE-STAGE, CENTRIFUGAL PUMPS WITH FLOOR-MOUNTED RECEIVER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Fluid Handling.
 - 2. ITT Corporation.
 - 3. Roth Pump Company.

4. Skidmore Pump.
5. Spence Engineering Company, Inc.
6. Spirax Sarco, Inc.

B. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pumps, controls, and accessories suitable for operation with steam condensate.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Choose between simplex or duplex configuration of pumps

C. Configuration: **[Simplex]** **[Duplex]** floor-mounted pump with receiver and float switches; rated to pump 200 deg F steam condensate.

D. Receiver:

1. Floor mounted.

Cast iron preferred for small to medium size units. Cast iron may not be available in larger receivers. Select steel for cylindrical receivers.

2. **[Close-grained cast iron]** **[Steel]**.
3. Externally adjustable float switches.
4. Flanges for pump mounting.
5. Water-level gage and dial thermometer.
6. Bronze fitting isolation valve between pump and receiver.
7. Lifting eyebolts.
8. Inlet, vent and an overflow.

E. Pumps:

1. Centrifugal, close coupled, vertical design.
2. Permanently aligned.
3. Bronze fitted.
4. Replaceable bronze case ring.
5. Mechanical seals rated at 250 deg F.
6. Mounted on receiver flange.

F. Control Panel:

1. Factory wired between pumps and float switches, for single external electrical connection.
2. Provide fused, control-power transformer if voltage exceeds 230 V ac.

Select appropriate NEMA rating below. Type 1 = normal protection against solid ingress. 3 = indoor or outdoor windblown dirt, dust, snow, rain, sleet. 12 = indoor protect versus falling dirt and settling dust, lint, fibers, and flyings and ingress of dripping and light splashing water.

3. NEMA 250, **[Type 1]** **[Type 3]** **[Type 12]** enclosure with hinged door and grounding lug, mounted on pump.
4. Motor controller for each pump.
5. Mechanical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.

6. Manual lead-lag control to override electrical pump alternator and manually select the lead pump.
7. Momentary-contact "TEST" push button on cover for each pump.
8. Numbered terminal strip.
9. Disconnect switch.

G. Capacities and Characteristics: See Schedules on Drawings.

2.2 REGENERATIVE TURBINE PUMPS WITH FLOOR-MOUNTED RECEIVER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ITT Corporation.
 2. Roth Pump Company.
 3. Spence Engineering Company, Inc.
 4. Spirax Sarco, Inc.
- B. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pumps, controls, and accessories suitable for operation with steam condensate.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Choose between simplex or duplex configuration of pumps

- C. Configuration: [Simplex] [Duplex] floor-mounted regenerative turbine pump with receiver and float switches; rated to pump 210 deg F steam condensate.
- D. Receiver:
1. Floor mounted.

Cast iron preferred for small to medium size units. Cast iron may not be available in larger receivers. Select steel for cylindrical receivers.

1. [Close-grained cast iron][Steel].
 2. Externally adjustable float switches.
 3. Flanges for pump mounting.
 4. Water-level gage and dial thermometer.
 5. Bronze fitting isolation valve between pump and receiver.
 6. Lifting eyebolts.
 7. Inlet, vent and an overflow.
- E. Pumps:
1. Regenerative turbine, close coupled.
 2. Permanently aligned.
 3. Bronze fitted.
 4. Mechanical seals rated at 250 deg F.
 5. Independent pump control circuit for each pump.

6. Mounted on base or receiver flange.
7. Rated to operate with a minimum of 2 feet of NPSH.

F. Control Cabinet:

1. Factory mounted on unit with drip lip and piano-hinged door.
2. Combination magnetic starter with fused disconnects and cover interlock,
3. Auto-off hand selector switch.
4. Numbered terminal strip.

G. Control Panel:

1. Factory wired between pumps and float switches, for single external electrical connection.
2. Provide fused, control-power transformer if voltage exceeds 230 V ac.

Select appropriate NEMA rating below. Type 1 = normal protection against solid ingress. 3 = indoor or outdoor windblown dirt, dust, snow, rain, sleet. 12 = indoor protect versus falling dirt and settling dust, lint, fibers, and flyings and ingress of dripping and light splashing water.

3. NEMA 250, [Type 1] [Type 3] [Type 12] enclosure with hinged door and grounding lug, mounted on pump.
4. Motor controller for each pump.
5. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
6. Manual lead-lag control to override electrical pump alternator and manually select the lead pump.
7. Momentary-contact "TEST" push button on cover for each pump.
8. Numbered terminal strip.
9. Disconnect switch.

H. Capacities and Characteristics: See Schedules on Drawings.

2.3 SINGLE-STAGE, CENTRIFUGAL PUMPS WITH ELEVATED RECEIVER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ITT Corporation.
2. Roth Pump Company.
3. Skidmore Pump.
4. Spence Engineering Company, Inc.
5. Spirax Sarco, Inc.

B. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pumps, controls, and accessories suitable for operation with steam condensate.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Choose between simplex or duplex configuration of pumps

- C. Configuration: **Simplex** **Duplex** floor-mounted pump with elevated receiver, float switches, and connecting piping; rated to pump 212 deg F steam condensate.
- D. Receiver:
1. Mounted on fabricated-steel supports.
 2. Close-grained cast iron.
 3. Externally adjustable float switches.
 4. Water-level gage and dial thermometer.
 5. Bronze isolation valves between receiver and pumps.
 6. Lifting eyebolts.
 7. Inlet, cascade baffle and convex heads.
- E. Pumps:
1. Centrifugal, close coupled.
 2. Permanently aligned.
 3. Bronze fitted with enclosed bronze impellers.
 4. Replaceable bronze case rings.
 5. Stainless-steel shafts.
 6. Mechanical seals rated at 250 deg F.
 7. Mounted on base below receiver.
 8. Rated to operate with a minimum of 2 feet of NPSH.
- F. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106/A 106M; Schedule 80; seamless steel.
- G. Fittings NPS 2 and Smaller: ASME B16.1, Class 125 cast iron, threaded.
- H. Fittings NPS 2-1/2 and Larger: ASTM A 234/A 234M, steel, for welded connections.
- I. Control Panel:
1. Factory wired between pumps and float switches, for single external electrical connection.
 2. Provide fused, control-power transformer if voltage exceeds 230 V ac.
- Select appropriate NEMA rating below. Type 1 = normal protection against solid ingress. 3 = indoor or outdoor windblown dirt, dust, snow, rain, sleet. 12 = indoor protect versus falling dirt and settling dust, lint, fibers, and flyings and ingress of dripping and light splashing water.**
3. NEMA 250, **Type 1** **Type 3** **Type 12** enclosure with hinged door and grounding lug, mounted on pump.
 4. Motor controller for each pump.
 5. Mechanical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
 6. Manual lead-lag control to override electrical pump alternator and manually select the lead pump.
 7. Momentary-contact "TEST" push button on cover for each pump.
 8. Numbered terminal strip.
 9. Disconnect switch.
- J. Capacities and Characteristics: See Schedules on Drawings.

2.4 VERTICAL, WET-PIT-MOUNTED DUPLEX PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ITT Corporation.
 - 2. Roth Pump Company.
 - 3. Skidmore Pump.
 - 4. Spence Engineering Company, Inc.
 - 5. Spirax Sarco, Inc.
- B. Description: Factory-fabricated, packaged, electric-driven pumps; with controls and accessories suitable for operation with steam condensate.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Configuration: Duplex pump with basin and float switches; rated to pump 200 deg F steam condensate.
- D. Basin: Cast iron, with hub-type inlets.
 - 1. Cast-iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket.
 - 2. Discharge pressure gages.
 - 3. Anchor Flange: Cast iron, attached to basin, in location and of size required to anchor basin to concrete slab.
- E. Basin Cover: Cast-iron or steel cover for each pump with gasketed openings for access to pumps, pump shafts, control rods, discharge piping, and vent connections.
- F. Pumps:
 - 1. Vertical, wet-pit mounted, flexible coupled, and suspended.
 - 2. Cast-iron casing with open inlet.
 - 3. Stainless-steel shaft with oil-lubricated, bronze, intermediate sleeve bearings; 48-inch maximum intervals where basin depth is more than 48 inches; and grease-lubricated, ball-type, thrust bearings.
 - 4. Shaft Couplings: Flexible, capable of absorbing vibration.
 - 5. Impeller: Bronze
 - 6. Mechanical seals rated at 250 deg F, with carbon rotating ring bearing on a ceramic seat held by a stainless-steel spring and enclosed by a flexible bellows and gasket.
- G. Pump Discharge Piping: Manufacturer's standard steel or bronze pipe unless otherwise indicated.
- H. Control Panel:
 - 1. Factory wired between pumps and float switches, for single external electrical connection.
 - 2. Provide fused, control-power transformer if voltage exceeds 230 V ac.

Select appropriate NEMA rating below. Type 1 = normal protection against solid ingress. 3 = indoor or outdoor windblown dirt, dust, snow, rain, sleet. 12 = indoor protect versus falling dirt and settling dust, lint, fibers, and flyings and ingress of dripping and light splashing water.

3. NEMA 250, **Type 1** **Type 3** **Type 12** enclosure with hinged door and grounding lug, mounted on pump.
4. Motor controller for each pump.
5. Mechanical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
6. Manual lead-lag control to override electrical pump alternator and manually select the lead pump.
7. Momentary-contact "TEST" push button on cover for each pump.
8. Numbered terminal strip.
9. Disconnect switch.

I. Capacities and Characteristics: See Schedules on Drawings.

2.5 ELECTRIC PUMP MOTORS

A. Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Select from the enclosure options below based on motor location environment.

2. Enclosure: **Open, dripproof** **Totally enclosed, fan cooled** **Totally enclosed, air over** **Open, externally ventilated** **Totally enclosed, nonventilated** **Severe duty** **Explosion proof** **Dust-ignition-proof machine**.
3. Motor Bearings: Permanently lubricated ball bearings.

Edit below if pump motors are located in unusual conditions

4. Unusual Service Conditions:
 - a. Ambient Temperature: **<Insert deg C>**.
 - b. Altitude: **<Insert feet>** above sea level.
 - c. High humidity.
5. Efficiency: Premium efficient.

Select appropriate NEMA class below. 1 = normal protection against solid ingress. 2 = protection against solid and water ingress (dripping and light splashing). 3 = indoor or outdoor windblown dirt, dust, snow, rain, sleet. 3R = indoor or outdoor falling dirt, dust, snow, rain, sleet. 4x = indoor or outdoor includes hose directed water. 5 = indoor protect versus falling dirt and settling dust, lint, fibers, and flyings. 6 = indoor or outdoor hose directed water and occasional submersion. 6P = indoor or outdoor hose directed water and prolonged submersion. 12 = indoor protect versus falling dirt and settling dust, lint, fibers, and flyings and ingress of dripping and light splashing water.

Provides a Degree of Protection Against the Following Conditions	Type of Enclosure									
	1 *	2 *	4	4X	5	6	6P	12	12K	13
Access to hazardous parts	X	X	X	X	X	X	X	X	X	X
Ingress of solid foreign objects (falling dirt)	X	X	X	X	X	X	X	X	X	X
Ingress of water (Dripping and light splashing)	...	X	X	X	X	X	X	X	X	X
Ingress of solid foreign objects (Circulating dust, lint, fibers, and flyings **)	X	X	...	X	X	X	X	X
Ingress of solid foreign objects (Settling airborne dust, lint, fibers, and flyings **)	X	X	X	X	X	X	X	X
Ingress of water (Hosedown and splashing water)	X	X	...	X	X	...	...	...
Oil and coolant seepage	X	X	X
Oil or coolant spraying and splashing	X
Corrosive agents	X	...	...	X	...	...	...
Ingress of water (Occasional temporary submersion)	X	X	...	...	...
Ingress of water (Occasional prolonged submersion)	X	...	...	...

* These enclosures may be ventilated.
 ** These fibers and flyings are nonhazardous materials and are not considered Class III type ignitable fibers or combustible flyings. For Class III type ignitable fibers or combustible flyings see the National Electrical Code, Article 500.

1. NEMA Design: **<Insert designation>**.
2. Service Factor: 1.15

2.6 PRESSURE-POWERED PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Fluid Handling.
2. Spence Engineering Company, Inc.
3. Spirax Sarco, Inc.
4. Watson McDaniels.

Select below for steam or compressed air for motive force.

- B. Description: Factory-fabricated, pressure-powered pumps with mechanical controls, valves, piping connections, and accessories suitable for pumping steam condensate using **steam** **compressed air**. System to be fabricated on a skid for lifting steam condensate using steam pressure, and not requiring electrical energy.

Retain below for pressurized condensate pumps, ASME rating is not necessary for pumps vented to atmosphere.

1. ASME Compliance: Fabricate and label steam condensate receivers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Label to be affixed with UN code stamp.

Choose between simplex or duplex configuration of pumps

- C. Configuration: **[Simplex]** **[Duplex]** pump with float-operated valve control.
1. Pump Body: Ductile iron, ASME rated to 125 psig.
 2. Piping Connections: Threaded; for steam condensate, operating medium, vent, and indicated accessories.
 3. Level Gage: Glass site gage with shutoff cocks.
 4. Valves: Stainless steel check valves on inlet and outlet.
 5. Internal Parts: Stainless-steel float, springs, and actuating mechanism.
 6. Inlet adjustable pressure regulating valves for motive source to vary outlet pressure as required.
 7. Furnish a factory fitted, removable insulation cover for pumps and receiver, and cycle counter to monitor pumping cycles.
- D. Receiver:
1. Receiver shall be factory mounted on steel supports above the pumps at a sufficient distance to permit proper pump operation.
 2. Body: Welded steel.

Manufacturer's standard is 3" for threaded and 4" as the starting point for flanged. This can be adjusted if desired, but adding flanges to 3" and smaller will add cost and lead time.

3. Connections: Threaded (or flanged) connections for pipe sizes 3" and under, and flanged connections for sizes 4" and larger. Connection sizes and locations shall be as indicated on the drawings, in addition to the connections required for pump suction.
4. Water-level sight gage glass with brass cocks and dial thermometer.

Select between options below.

5. **[Carbon steel]** **[Stainless steel]** fitting isolation valve between pump and receiver.
6. Inlet, vent and an overflow. Overflow may be

Retain below for skid mounted systems.

- E. All piping to skid mounted pump systems shall be factory installed with single inlet connection to receiver, an outlet connection per pump discharge, and a connection for vent and motive pressure piping.

Manufacturer's standard is for schedule 40 piping, option is available for schedule 80 but adds cost and lead time.

- F. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106/A 106M; Schedule **[40]** **[80]**; seamless steel. All piping to pumps shall be factory installed with single outlet connection to skid.
- G. Fittings: ASME B16.1, Class 125 cast iron, threaded.
- H. Connections: Sizes and locations shall be as indicated on the drawings, in addition to the connections required for pump suction.
- I. Entire assembly shall be factory painted.
- J. Capacities and Characteristics: See Schedules on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install pumps according to HI 1.1-1.2, HI 1.3, and HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps.
- D. Install thermometers on receiver.
- E. Install pressure gages on pump discharge piping.
- F. Equipment Mounting:
 - 1. Install pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in

Select one of the two paragraphs below

- 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- 3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
- B. Where installing piping adjacent to machine, allow space for service and maintenance.
- C. Install a globe and check valve and pressure gage before inlet of each pump and a gate and check valve at pump outlet.
- D. Pipe drain to nearest floor drain for overflow and drain piping connections.

- E. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.

Retain two paragraphs below for electric pumps only

- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

- A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Clean strainers.
 3. Set steam condensate pump controls.
 4. Set pump controls for automatic start, stop, and alarm operation.
 5. Perform the following preventive maintenance operations and checks before starting:
 - a. Set float switches to operate at proper levels.
 - b. Set throttling valves on pump discharge for specified flow.
 - c. Check motors for proper rotation.
 - d. Test pump controls and demonstrate compliance with requirements.
 - e. Replace damaged or malfunctioning pump controls and equipment.
 - f. Verify that pump controls are correct for required application.
 6. Start steam condensate pumps according to manufacturer's written startup instructions.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps.

END OF SECTION 232223

KSU DESIGNERS NOTES:

1. Receiver Vents - Extend fully outdoors to safe location, roof preferred (review with OUA). Insulate vent piping indoors and outdoors for personnel protection.
2. Condensate Pumps – Steam Power Pressure Type – Watson McDaniels is the Preferred Manufacturer

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Refrigerant pipes and fittings.
 - 2. Refrigerant piping valves and specialties.
 - 3. Refrigerants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve, refrigerant piping, and piping specialty.
 - 1. Include pressure drop, based on manufacturer's test data, for the following:
 - a. Thermostatic expansion valves.
 - b. Solenoid valves.
 - c. Hot-gas bypass valves.
 - d. Filter dryers.
 - e. Strainers.
 - f. Pressure-regulating valves.
- B. Shop Drawings:
 - 1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
 - 2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
 - 3. Show interface and spatial relationships between piping and equipment.
 - 4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
- D. Comply with the Ohio Building Code.

1.7 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-134a:
 - 1. Suction Lines for Air-Conditioning Applications: 115 psig.
 - 2. Suction Lines for Heat-Pump Applications: 225 psig.
 - 3. Hot-Gas and Liquid Lines: 225 psig.
- B. Line Test Pressure for Refrigerant R-407C:
 - 1. Suction Lines for Air-Conditioning Applications: 230 psig.
 - 2. Suction Lines for Heat-Pump Applications: 380 psig.
 - 3. Hot-Gas and Liquid Lines: 380 psig.
- C. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type L or ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8/A5.8M.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Working Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Apollo Flow Controls; Conbraco Industries, Inc.
 - 2. Danfoss Inc.
 - 3. Emerson Climate Technologies.
 - 4. Heldon Products; Henry Technologies.
 - 5. Parker Hannifin Corp.
 - 6. Paul Mueller Company.
 - 7. Refrigeration Sales, Inc.
- B. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg F.
- C. Check Valves:
 - 1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.

2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with AHRI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Superheat: Adjustable.
6. Reverse-flow option (for heat-pump applications).
7. End Connections: Socket, flare, or threaded union.
8. Working Pressure Rating: 700 psig for R410A, 450 psig for R134a and R-407c systems.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: External.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 24-V ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.

7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

M. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

N. Receivers: Comply with AHRI 495.

1. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

O. Liquid Accumulators: Comply with AHRI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

- A. ASHRAE 34, R-134a: Tetrafluoroethane.
- B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
- C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-134a

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:

1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 2. NPS 2 to NPS 4: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
- D. Safety-Relief-Valve Discharge Piping: Match piping type and joining methods described for piping upstream of relief valve.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-407C

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
1. NPS 1 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 2. NPS 1-1/4 to NPS 4: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- D. Safety-Relief-Valve Discharge Piping: Match piping type and joining methods described for piping upstream of relief valve.

3.3 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 2 to NPS 3-1/2 for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Suction Lines NPS 4 for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
1. NPS 5/8 and Smaller: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 2. NPS 3/4 to NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 3. NPS 1-1/4 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
 4. NPS 1-1/2 to NPS 2: Copper, Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

- E. Safety-Relief-Valve Discharge Piping: Match piping type and joining methods described for piping upstream of relief valve.

3.4 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

3.5 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- H. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down. Install piping adjacent to machines to allow service and maintenance.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.
- M. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- N. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- O. Install refrigerant piping in protective conduit where installed belowground.
- P. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

- Q. Slope refrigerant piping as follows:
1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 2. Install horizontal suction lines with a uniform slope downward to compressor.
 3. Install traps and double risers to entrain oil in vertical runs.
 4. Liquid lines may be installed level.
- R. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- T. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

- F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.7 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Support multi-floor vertical runs at least at each floor.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.9 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.10 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Refrigerant piping shall be isolated from all hangers with an approved pipe wrap, gasket or isolator to prevent transmitting vibration to the building. Any piping exposed to outside conditions shall have UV protective coating, white finish, and covered in PVC pipe wrap or ASJ where insulated.
- C. The Contractor shall provide and pay for pressure piping permits associated with refrigerant systems. A copy of the approval certificate is to be supplied to Kent State University. Associate shall also obtain contractors pressure piping welding certificates.
- D. All refrigerant piping systems shall require field reports listing system quantity, evacuation procedure and maintain an EPA log on any system that requires field addition or subtraction once system is installed at KSU. This applies to systems which have 50# or more of refrigerant.

- E. Refrigerant pipe fittings to utilize long radius fittings.

END OF SECTION 232300

KSU DESIGNERS NOTES:

1. Specifications to include testing procedures applicable to system and reviewed with OUA.
2. Any system or piece of equipment which has a greater amount than 50 # at any one location (Room) shall be supplied with a refrigerant monitoring system connected into our BAS. System type shall be reviewed with OUA. All system shall also be supplied with personal safety Kits complete with training MSA approved. This devise shall be reviewed with OUA. Manufacturers Sherlock, Halogard, and Emerson.
3. Do not specify equipment using refrigerant scheduled for phase out within 20 years of design project design date. All system types shall be reviewed with OUA.

SECTION 232500 – CHEMICAL TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. HVAC water-treatment systems.
- B. Chemical treatment test equipment.
- C. HVAC water-treatment chemicals.

All three of the above items shall be reviewed with Applied Specialties and OUA. For Regional Campus Projects review with Gardiner and OUA

1.2 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available, HVAC system equipment material characteristics and functional performance characteristics.
- C. Provide temporary water treatment for systems until facility has final connections.

1.3 SUBMITTAL REQUIREMENTS

- A. Insure contractors and design provide product data: Including rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
 - 1. Water meters.
 - 2. Inhibitor injection timers.
 - 3. pH controllers.
 - 4. TDS controllers.
 - 5. Chemical solution tanks.
 - 6. Injection pumps.
 - 7. Chemical test equipment.
 - 8. Chemical material safety data sheets.
 - 9. Coupon rack assemblies.
- B. Shop Drawings are required under the CD Phase: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Record actual locations of equipment and piping, including sampling points and locations of chemical injectors.
 - 2. Provide Wiring Diagrams: Power and control wiring.

- C. Specify level of field quality-control test reports which will be required. Reports at Minimum shall include inhibitor levels, pH, conductivity, equipment conditions, chemical inventory and water usage projections.
- D. Operation and Maintenance manuals shall be included into design and shall indicate training hours for systems. Number of hours shall be reviewed with KSU vendors and OUA to best determine level of training required.
- E. Minimum Chemical treatment design shall include:
 - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
 - 2. Water Analysis: Illustrate water quality available at Project site.
 - 3. Certification of compliance: Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposal disposal.
 - 4. Provide all MSDS sheets and amounts required to be stored and installed into system start-up.

1.4 DESIGN QUALITY ASSURANCE

- A. Outline the HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water treatment service provider with certified water technologists, capable of analyzing water qualities, qualifications for contractor installing water-treatment equipment.

1.5 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping, heating, hot-water piping, condenser-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
 - 1. Initial makeup and (and subsequent analysis of water quality changes) system water analysis with HVAC water-treatment recommendations.
 - 2. Startup assistance for Contractor to flush the systems, clean with disinfectant detergents and initially fill systems with required chemical treatment prior to operation.
 - 3. Minimum 4 hours of on-site training of plant engineers to use water treatment equipment, to handle and administer treatment chemicals.
 - 4. Weekly field service and consultation.
 - 5. Customer report charts and log sheets need to be provided were applicable.
 - 6. Laboratory technical analysis when applicable review with OUA.
 - 7. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following airport wide water treatment vendor:

Edit below as applicable to project.

1. Applied Specialties, Inc. (Kent Campus)
 - a. PO Box 307, Avon Lake, Ohio 44012, Ph: 440-933-9442
 - b. Mike Peters, peters.mike@appliedspecialties.com, Cell 330-606-9391
2. Chemtex (Gardiner) Regional Campuses.
 - a. 31200 Bainbridge Road, Solon Ohio, 44139
 - b. Brian Riegel briegel@whgardiner.com, Ph: 440-248-3400

2.2 AUTOMATIC CHEMICAL-FEED EQUIPMENT REVIEW WITH OUA

- A. Inhibitor injection Timers:

1. Microprocessor-based controller with LCD display in NEMA 4X, Type 12 enclosure with gasket and lockable door. Interface for start/stop and status indication at BAS.
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand off auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.

- B. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

- C. Injection Assembly:

1. Quill: Minimum NPS ½ (DN 15) with insertion length sufficient to discharge into at least 25 percent of pie diameter.
2. Ball Valve: Two piece, stainless steel.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig (4137 kPa) at 200 deg F (93 deg C).
5. Materials of construction: Stainless steel 316, Nickel alloy, Carpenter 20, PVC.

- D. Fail-Safes and Alarms

1. Corrosion safety interlock: Alarm indication, lock-out all chemical feed, open bleedoff valve to flush corrosive water from system.
2. PH interlock: Alarm indication, lock-out all chemical feed, open bleed-off valve to reduce total dissolved solids in cooling tower water .

3. Flow interlock (on loss of flow): Alarm indication, lock-out all control outputs and chemical feeds.
- E. Low Level Alarms
1. Low level alarm system to monitor chemical solution level in inhibitor, pH modifier (acid or alkali), biocide, and dispersant drums.
 2. Alarm probes, suitable current system capacity and connected with flexible cable.
 3. Signal output suitable for remote alarm function in addition to local alarm.

2.3 CHEMICAL TREATMENT TEST EQUIPMENT REVIEW WITH OUA

Review below with KSU OUA.

- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, phosphate, silica and hardness; oxygen scavenger and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.
- B. Sample Cooler:
1. Shell: Cooling Water
 - a. Material: ASTM A 666, Type 304 stainless steel.
 - b. Pressure Rating: Minimum 250 psig (1725 kPa).
 - c. Temperature Rating: Minimum 450 deg F (232 deg C).
 2. Capacities and Characteristics:
 - a. Tube: Sample.
 - 1) Flow Rate: 0.25 gpm (0.016 L/s).
 - 2) Entering Temperature: 400 deg F (204 deg C).
 - 3) Leaving Temperature: 88 deg F (31 deg C).
 - 4) Pressure Loss: 6.5 psig (44.8 kPa).
 - b. Shell: Cooling Water
 - 1) Flow Rate: 3 gpm (0.19 L/s).
 - 2) Entering Temperature: 70 deg F (21 deg C).
 - 3) Pressure Loss: 1.0 psig (6.89 kPa).
- C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons in accordance with ASTM D2688. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
1. Two-station rack for closed-loop systems.
 2. Two station rack for open systems.

2.4 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified herein.

2.5 GLYCOL SYSTEMS – HEATING AND COOLING SHALL BE REVIEW WITH OUA

- A. Use "Environmentally Friendly" glycol. Polypropylene Glycol (C₃H₈O₂) only shall be used.
- B. Coordinate compatibility of glycol with materials used in piping, valves, equipment and accessories.
- C. Provide glycol feed system on all designs having the need for this type of system.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure.
- C. Install water testing equipment on wall near water chemical application equipment.
- D. Install interconnecting control wiring for chemical treatment controls and sensors.
- E. Mount sensors and injectors in piping circuits.
- F. Install automatic chemical-feed equipment for condenser water and include the following:
 - 1. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
 - a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection for the heating and chilled water loops only. Pumps for the cooling towers and steam boilers shall operate base on the actual chemistry of the water.

2. Install test equipment and provide test-kit to KSU. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
 3. Install TDS controller with sensor and bleed valves.
 - a. Bleed valves shall cycle to maintain maximum TDS concentration.
 4. Install pH, conductivity and Oxidation-Reduction Potential (ORP) sensors with integral controller, injection pumps and solution tanks.
 5. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.
 - a. Injection pumps shall operate to feed biocide on an alternating basis.
- G. Install corrosion resistant drip pan, a minimum of 3 in (75 mm) high, under tanks and pumps. Intent is to contain minor leaks.

3.3 CONNECTIONS

- A. Install piping adjacent to equipment to allow service and maintenance.
- B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with 6-inch-long brass nipple for the pipes 1 ½ inch and smaller and dielectric flange for the pipes 2 inch and larger. Dielectric flanges are allowed in the pump and fan rooms only.
- C. Install unions, shutoff valves on HVAC water-treatment equipment inlet and outlet.
- D. Provide backflow preventers.
- E. Provide appropriate equipment grounding.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Install and retrieve corrosion coupons every 90 days to generate quarterly reports on corrosion rates of steel and copper with photographic images of the coupons.
 2. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 3. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.

4. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
 5. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 6. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 7. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 8. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 9. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified herein. Submit written reports of water analysis advising KSU of changes necessary.
- E. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
 2. Acidity and Alkalinity: ASTM D 1067.
 3. Iron: ASTM D 1068.
 4. Water Hardness: ASTM D 1126.
 5. Chloride: ASTM D4458
 6. Copper: ASTM D1688
 7. pH: ASTM D5464

3.5 TRAINING

- A. Engage a factory-authorized service representative to train KSU's Maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
- B. Provide a minimum of 12 hours (3 shifts) of classroom and hands on training to KSU Maintenance personnel on handling and testing of treatment chemicals with "how-to-use" video that details exact operating procedures of equipment.

3.6 FINAL CONNECTION TO SITE UTILITIES

- A. Do not circulate any water from the site chilled and high temperature hot water mains until the CUP water treatment contractor has certified the water quality of both sides of the site utility isolation valves.
- B. After connection to plant utilities are achieved remove temporary bypass pipes and cap.

END OF SECTION 232500

KSU DESIGNERS NOTES:

1. All associates shall coordinate the chemical treatment designs and specifications with “Applied Specialties, Inc., PO Box 307, Avon Lake, Ohio 44012, Ph: 440-933-9442” for all Kent Campus Projects.
 - a. Contact person: Mike Peters, peters.mike@appliedspecialties.com, Cell 330-606-9391
2. For all Projects at Regional Campuses review systems and design with “Gardiner (Chemtex), 31200 Bainbridge Road, Solon Ohio, 44139”
 - a. Contact person: Brian Riegel briegel@whgardiner.com, Ph: 440-248-3400

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only items relevant to project.

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round[and flat-oval] ducts and fittings.
4. Double-wall round[and flat-oval] ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.
9. Seismic-restraint devices.

- B. Related Sections:

Retain Sections in subparagraphs below that contain requirements Contractor might expect to find in this Section but are specified in other Sections.

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

- A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

Retain below if Seismic Requirements are applicable to the project.

12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Welding certificates.
- C. Field quality-control reports.

Retain section below and edit accordingly when welding is required.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- A. Structural Performance: Duct hangers and supports[**and seismic restraints**] shall withstand the effects of gravity[**and seismic**] loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" [**and**] [**ASCE/SEI 7**]. [**Seismically brace duct hangers and supports in accordance with**] [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."**] [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems - OSHPD Edition."**]
1. Seismic Hazard Level (SHL): [**AA**] [**A**] [**B**] [**C**] [**D**].
 2. Connection Level: [**1**] [**2**].
- B. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- E. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

Select between 304 and 316 stainless steel for ductwork exposed to weather. 304 is an economical and practical choice for most environments, but it doesn't have the chloride resistance of 316. The slightly higher price point of 316 is well worth it in areas with high chloride exposure, especially the coast and heavily salted roadways.

2. For ducts exposed to weather, construct of [**Type 304**] [**Type 316**] stainless steel indicated by manufacturer to be suitable for outdoor installation.

- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

Retain below when required for all joints to be welded. Clearly identify systems to be welded.

3. [**Where specified for specific applications, all joints shall be welded.**]

- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

Retain below when required for all joints to be welded. Clearly identify systems to be welded.

1. **[Where specified for specific applications, all joints shall be welded.]**

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Linx Industries (formerly Lindab).
2. McGill AirFlow LLC.
3. SEMCO LLC.
4. Set Duct Manufacturing.
5. Tangent Air.
6. United Sheet Metal Div., United McGill Corp.

- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

Select between 304 and 316 stainless steel for ductwork exposed to weather. 304 is an economical and practical choice for most environments, but it doesn't have the chloride resistance of 316. The slightly higher price point of 316 is well worth it in areas with high chloride exposure, especially the coast and heavily salted roadways.

2. For ducts exposed to weather, construct outer duct of **[Type 304]** **[Type 316]** stainless steel indicated by manufacturer to be suitable for outdoor installation.

- C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

Retain below when required for all joints to be welded. Clearly identify systems to be welded.

3. [Where specified for specific applications, all joints shall be welded.]

- D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

Retain below when required for all joints to be welded. Clearly identify systems to be welded.

1. [Where specified for specific applications, all joints shall be welded.]

- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.
 4. Cover insulation with polyester film complying with UL 181, Class 1.

Select from the inner duct lining for either perforated or solid liners.

- F. Inner Duct: Minimum 24-gauge [perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent] [solid galvanized sheet steel].

Retain below when flat oval ducts are indicated in addition to standard round ducts.

2.4 SINGLE-WALL ROUND[AND FLAT-OVAL] DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Construct ducts of galvanized sheet steel unless otherwise indicated.

Select between 304 and 316 stainless steel for ductwork exposed to weather. 304 is an economical and practical choice for most environments, but it doesn't have the chloride resistance of 316. The slightly higher price point of 316 is well worth it in areas with high chloride exposure, especially the coast and heavily salted roadways.

2. For ducts exposed to weather, construct of [Type 304] [Type 316] stainless steel indicated by manufacturer to be suitable for outdoor installation.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Linx Industries (formerly Lindab).
 - b. McGill AirFlow LLC.
 - c. SEMCO LLC.
 - d. Set Duct Manufacturing.
 - e. Tangent Air.

- f. United Sheet Metal Div., United McGill Corp.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

Retain below when flat oval ducts are indicated in addition to standard round ducts.

2.5 DOUBLE-WALL ROUND[**AND FLAT-OVAL**] DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Linx Industries (formerly Lindab).
 - 2. McGill AirFlow LLC.
 - 3. SEMCO LLC.
 - 4. Set Duct Manufacturing.
 - 5. Tangent Air.
- B. United Sheet Metal Div., United McGill Corp. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
 - 1. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch.3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

- a. Construct ducts of galvanized sheet steel unless otherwise indicated.

Select between 304 and 316 stainless steel for ductwork exposed to weather. 304 is an economical and practical choice for most environments, but it doesn't have the chloride resistance of 316. The slightly higher price point of 316 is well worth it in areas with high chloride exposure, especially the coast and heavily salted roadways.

- b. For ducts exposed to weather, construct outer duct of [Type 304] [Type 316] stainless steel indicated by manufacturer to be suitable for outdoor installation.
- 2. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- 3. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- 4. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

Select from the inner duct lining for either perforated or solid liners.

- C. Inner Duct: Minimum 24-gauge [perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent] [solid galvanized sheet steel].
- D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.

Select from the two options below.

- 3. Coat insulation with antimicrobial coating.
- 4. Cover insulation with polyester film complying with UL 181, Class 1.

Retain only when kitchen hoods apply to project.

2.6 KITCHEN HOOD EXHAUST DUCTWORK

- A. General: Fabricate kitchen hood exhaust ducts and supports, used for smoke and vapor removal from cooking equipment. Ductwork shall be of all welded construction and shall comply with SMACNA "HVAC Duct Construction Standards", and NFPA 96 "Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment", and with all governing building codes.
1. Fabricate of 16 ga. minimum black steel where concealed.
 2. Fabricate of 18 ga. minimum stainless steel where exposed on occupied areas.
- B. Alternate kitchen hood exhaust: prefabricated grease duct by Metal-Fab 4G, Selkirk Z3, or Jeremias DWFL-SC. UL listed for 0" clearance to combustibles.

Retain only when dishwasher exhaust, cage washer exhaust, sterilizer exhaust, etc. Use aluminum only for diluted we exhaust.

2.7 WET AIR EXHAUST DUCTWORK

- A. Fabricate wet air exhaust ducts and accessories of minimum 18 ga. material made liquid tight with continuous external weld for all seams and joints. Provide neoprene gaskets at flanged connections.
1. Fabricate of stainless steel.
 2. Fabricate of aluminum.

Retain below where fabricated exhaust hoods are required.

2.8 FABRICATED EXHAUST HOODS

- A. General: Provide fabricated exhaust hoods where indicated on the drawings.
1. Materials: Unless indicated otherwise on the drawings, all fabricated exhaust hoods shall be fabricated from 18 ga. 316 stainless steel.
 2. Fabrications: Exhaust hoods shall be fabricated with all joints and seams continuously welded. Welded joints and seams shall be ground smooth with the adjoining surfaces and all exposed surfaces of the hood shall be polished.

Retain only where ducts pierce lead lining of x-ray rooms or if unusual sound control application.

2.9 LEAD COVERED DUCTWORK

- A. Sheet Lead: One-eighth inch thick, securely installed, free of waves, lumps or wrinkles and with as few joints as possible.
- B. Joints shall be made to obtain x-ray absorption equivalent to adjacent sheet lead, and finished smooth and neat.

Retain only where ducts penetrate shielded rooms (example computer rooms).

2.10 ELECTROSTATIC SHIELDING

- A. At the point of penetration of shielded rooms, ducts shall be made electrically discontinuous by means of a flexible, non-conductive connection outside shielded room.
- B. Metallic duct portion inside shielded room shall be electrically bonded to shielding.

2.11 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

Retain only the types of sheet metal specified for the project.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick[**on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface**].
 - 3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.
- F. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

Retain below where steel is to have antimicrobial coating installed. Not typical for most projects.

G. Factory- or Shop-Applied Antimicrobial Coating:

- 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
- 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
- 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested in accordance with ASTM D 3363.

4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
 5. Shop-Applied Coating Color: [Black] [White].
 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- H. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- I. Tie Rods: Galvanized steel, 1/4-inch-minimum diameter for lengths 36 inches or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

Retain Duct Liner only when used. Note some clients (Kent State University) prohibit the use of duct liner except for on low velocity transfer air ducts. Flexible elastomeric insulation is not suitable for temperatures greater than 220 Degrees F. Recommend NOT using ductliner on systems 2500 fpm or greater.

2.12 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.
 2. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534/C 534M, Type II, Grade I; and with NFPA 90A or NFPA 90B.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. Ductmate Industries, Inc.
 - d. K-Flex USA.
 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
- C. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

2.13 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.

Retain sections below only if Flanged or O-Ring seals are to be used to connect factory fabricated round duct fitting joints. O-Rings are generally available only for sizes 3-24". O-Rings work well to seal duct penetrations on exposed ductwork without the use of brushed on duct sealant.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

- 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
- 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
- 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.14 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

2.15 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. CADDY; a brand of nVent.
 - 3. Hilti, Inc.
 - 4. Kinetics Noise Control, Inc.
 - 5. Mason Industries, Inc.
 - 6. TOLCO.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by [an evaluation service member of the ICC Evaluation Service][an agency acceptable to authorities having jurisdiction].
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least [four] <[Insert number]> times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: [ASTM A 603, galvanized] [ASTM A 492, stainless]-steel cables with end connections made of galvanized-steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: [Steel tube or steel slotted-support-system sleeve with internally bolted connections] [Reinforcing steel angle clamped] to hanger rod.

- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested in accordance with ASTM E 488/E 488M.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. General: Examine areas and conditions under which metal ductwork and accessories are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of ductwork and accessories, but do not necessarily show all required fittings and offsets that may be necessary to connect ducts to equipment, terminal units, diffusers, etc. and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the Owner. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grids where applicable. Duct sizes on drawings are external sizes which shall be altered by contractor (with approval of engineer) to other dimensions with the same or better area and friction characteristics where necessary to avoid interferences and clearance difficulties. Coordinate duct layout and duct accessory arrangement with Drawings.
- C. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- D. Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight (2% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Construct and install each duct system for the specific duct pressure classification indicated. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at a maximum interval of 16 feet, and at every floor.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceiling and lighting layouts and similar finished work.

- F. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- G. Install ducts in maximum practical lengths with fewest possible joints.
- H. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- J. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- K. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures unless ductwork serves these rooms.
- L. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- M. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.
- N. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- O. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- P. Temperature Control Dampers: Install all temperature control dampers where indicated on the drawings unless factory installed in air handling equipment.
 - 1. Provide necessary transitions required to install dampers larger than duct size. Do not install control dampers smaller than duct size.
 - 2. Assemble multiple section dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
 - 3. See drawings for furnishing recommendation for temperature control dampers.
- Q. Elbows: Use long-radius elbows wherever they fit.
 - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes in supply air systems, and elsewhere as indicated.
 - 2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

- R. Branch Connections: Use lateral or conical branch connections.
- S. Flexible Connections: Connect metal ductwork to equipment as indicated. Provide flexible connection for each ductwork connection to equipment mounted on vibration isolators and/or equipment containing rotating machinery, and elsewhere as indicated.
- T. Coordination: Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR TYPE 1 COMMERCIAL KITCHEN GREASE HOOD EXHAUST DUCT

- A. Install ducts in accordance with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operation"; SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; and SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines" and local codes unless otherwise indicated.
- B. Install all ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- C. All ducts exposed to view shall be constructed of stainless or carbon steel as per "Duct Schedule" Article.
- D. Provide for thermal expansion of ductwork through 2000 deg F (1093 deg C) temperature range. All joints shall be welded and shall be telescoping, bell, or flange joint as per NFPA 96.
- E. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate panels on sides of duct 1-1/2" minimum from bottom, and fitted with grease-tight covers of same material as duct unless otherwise indicated.
- F. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 ADDITIONAL INSTALLATION REQUIREMENTS FOR WET AIR EXHAUST DUCTS SERVING COMMERCIAL DISHWASHERS AND OTHER HIGH-HUMIDITY LOCATIONS

- A. Install dishwasher exhaust ducts and other exhaust ducts from wet, high-humidity locations without dips and traps that may hold water. Fabricate joints and seams with continuous welds for liquid tight construction. Install to be self-draining back to equipment. Slope ducts a minimum of 2 percent back to dishwasher or toward drain.
- B. Provide a drain pocket at each low point and at the base of each riser with a 1-inch trapped copper drain from each drain pocket to open site floor drain.
- C. Minimize number of transverse seams.
- D. Do not locate longitudinal seams on bottom of duct.
- E. Provide access doors in side of ducts where indicated.

3.5 ADDITIONAL INSTALLATION REQUIREMENTS FOR LABORATORY EXHAUST AND FUME HOOD EXHAUST DUCTS

- A. Install in accordance with SMACNA HVAC Duct Construction Standards. Provide the absolute minimum number of bends and obstructions. The interior all ducts shall be smooth and free of obstructions. All joints shall be air tight.
- B. Install ducts in accordance with NFPA 45, "Fire Protection for Laboratories Using Chemicals."
- C. Install exhaust ducts without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to hood or inlet. Where indicated on Drawings, install trapped drain piping.
- D. Connect duct to fan, fume hood, and other equipment indicated on Drawings.

3.6 ADDITIONAL INSTALLATION REQUIREMENTS FOR INDUSTRIAL EXHAUST DUCTS

- A. Install in accordance with SMACNA industrial duct construction standards. Provide the absolute minimum number of bends and obstructions. The interior of all ducts shall be smooth and free of obstructions. All joints shall be air tight. Provide accessories as indicated. Provide cleanouts such that all portions of ductwork installation can be cleaned without disassembling ductwork.

3.7 ADDITIONAL INSTALLATION REQUIREMENTS FOR FABRICATED EXHAUST HOODS

- A. General: Install exhaust hood having dimensions and at a height above the finished floor as indicated on the drawings.
- B. Exhaust Ductwork: Unless indicated otherwise on the drawings, hood exhaust ductwork shall be installed with a uniform pitch of 1" in 25 feet toward the exhaust hood.

3.8 DUCTWORK EXPOSED TO WEATHER

Retain and edit below when ductwork is installed outdoors, exposed to weather.

- A. All external joints are to **[be welded]** **[have secure watertight mechanical connections]**. Seal all openings to provide weatherproof construction.
- B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.
- C. Single Wall:

Select between 304 and 316 stainless steel for ductwork exposed to weather. 304 is an economical and practical choice for most environments, but it doesn't have the chloride resistance of 316. The slightly higher price point of 316 is well worth it in areas with high chloride exposure, especially the coast and heavily salted roadways.

- 1. Ductwork shall be **[Type 304]** **[Type 316]** stainless steel.
- 2. Ductwork shall be galvanized steel.
 - a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 099113 "Exterior Painting."
- 3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

- D. Double Wall:

Select between 304 and 316 stainless steel for ductwork exposed to weather. 304 is an economical and practical choice for most environments, but it doesn't have the chloride resistance of 316. The slightly higher price point of 316 is well worth it in areas with high chloride exposure, especially the coast and heavily salted roadways.

- 1. Ductwork shall comply with requirements in "Double-Wall Rectangular Ducts and Fittings" or "Double-Wall Round **[and Flat-Oval]** Ducts and Fittings" Article.
- 2. Ductwork outer wall shall be **[Type 304]** **[Type 316]** stainless steel indicated by manufacturer to be suitable for outdoor installation.
- 3. Provide interstitial insulation.

3.9 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes as specified below and in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal non-welded seams and joints as follows:
 - 1. Duct Pressure Class From -2" W.C. to +2" W.C.: Seal all transverse joints and longitudinal seams. Sealant may be omitted from longitudinal seams of supply ductwork downstream of terminal units when the total length of the duct run from the terminal unit is less than 20 feet.
 - 2. All Other Ductwork: Seal all transverse joints, longitudinal seams and duct penetrations.

- C. Seal externally insulated ducts prior to insulation installation.
- D. Seal ductwork prior to start-up of fans, per sealant manufacturer's recommendations. Ventilate areas as required to prevent buildup of sealant odors in occupied spaces.

3.10 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Install hangers and connectors in accordance with manufacturer's recommendation. End connection assemblies with automatic locking / clamping devices to be installed to maintain the minimum proper installation angle per the manufacturer to insure proper locking.
- C. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

Retain below only if Seismic Requirements apply to project.

- 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- D. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- E. Hangers Exposed to View: Threaded rod and angle or channel supports.
- F. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- G. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

Retain and edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

3.11 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with [SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."] [SMACNA's "Seismic Restrain Manual: Guidelines for Mechanical Systems - OSHPD Edition."] [ASCE/SEI 7.]

1. Space lateral supports a maximum of [40] <Insert dimension> feet o.c., and longitudinal supports a maximum of [80] <Insert dimension> feet o.c.
 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by [an evaluation service member of the ICC Evaluation Service] [OSHDP] [an agency acceptable to authorities having jurisdiction].
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.12 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.13 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.14 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Supply, Return, and Exhaust Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
 - 5. Test for leaks before applying external insulation.
 - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 7. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.15 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. For cleaning of existing ductwork, see Section 230130.52 "Existing HVAC Air Distribution System Cleaning."
- C. Use duct cleaning methodology as indicated in NADCA ACR.
- D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.16 STARTUP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

Edit Duct Schedule below or provide on drawings indicating duct class ratings and materials types / finishes for all services on projects.

3.17 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
- B. Supply Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive [1-] [2-] -inch wg.
 2. Ducts Connected to Constant-Volume Single Zone Air-Handling Units:
 - a. Pressure Class: Positive [2-] [3-] <Insert number> inch wg.
 3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
 - a. Pressure Class: Positive [3-] [4-] <Insert number> inch wg.
 4. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive [2-] [3-] [4-] <Insert number> inch wg.
- C. Return Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative [1-] [2-] <Insert number> inch wg.
 2. Ducts Connected to Single Zone Air-Handling Units:
 - a. Pressure Class: Positive or negative [2-] [3-] <Insert number> inch wg.
 3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
 - a. Pressure Class: Positive or negative [2-] [3-] [4-] <Insert number> inch wg.
- D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

- a. Pressure Class: Negative [1-] [2-] [3-] <Insert number>inch wg.
2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative [2-] [3-] <Insert number>inch wg.
3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
 - a. Exposed to View: Type 304, stainless-steel sheet, [No. 4] [No. 3] finish.
 - b. Concealed: [Type 304, stainless-steel sheet, No. 2D finish] [Carbon-steel sheet].
 - c. Welded seams and joints.
 - d. Pressure Class: Positive or negative [2-] [3-] [4-] <Insert number>inch wg.
 - e. Airtight/watertight.
4. Ducts Connected to Dishwashers, Dishwasher Hoods, and Other High-Humidity Locations:
 - a. Type 304, stainless-steel sheet.
 - b. Exposed to View: [No. 4] [No. 3] finish.
 - c. Concealed: [No. 2D] <Insert finish> finish.
 - d. Welded longitudinal seams; welded or flanged transverse joints with watertight EPDM gaskets.
 - e. Pressure Class: Positive or negative [2-] [3-] <Insert number>inch wg.
 - f. Airtight/watertight.
5. Ducts Connected to Fans Exhausting Fume Hood, Laboratory, and Process (ASHRAE 62.1, Class 3 and Class 4) Air:
 - a. [Type 316] [Type 304], stainless-steel sheet.
 - 1) Exposed to View: [No. 4] [No. 3] finish.
 - 2) Concealed: [No. 2B] [No. 2D] finish.
 - b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.
 - c. Pressure Class: Positive or negative [3-] [4-] [6-] <Insert number>inch wg.
 - d. Airtight/watertight.
6. Ducts Connected to Equipment Not Listed above:
 - a. Pressure Class: Positive or negative [2-] [3-] [4-] <Insert number>inch wg.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative [1-] [2-] <Insert number>inch wg.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative [2-] [3-] <Insert number>inch wg.
- F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. PVC-Coated Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
3. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
4. Aluminum Ducts: Aluminum.

G. Liner:

1. Supply-Air Ducts: [Fibrous glass, Type I] [Flexible elastomeric], [1] [1-1/2] [2] <Insert dimension> inch(es thick).
2. Return-Air Ducts: [Fibrous glass, Type I] [Flexible elastomeric], [1] [1-1/2] [2] <Insert dimension> inch(es thick).
3. Exhaust-Air Ducts: [Fibrous glass, Type I] [Flexible elastomeric], [1] [1-1/2] [2] <Insert dimension> inch(es thick).
4. Supply Fan Plenums: [Fibrous glass, Type I] [Flexible elastomeric], [1] [1-1/2] [2] <Insert dimension> inch(es thick).
5. Return- and Exhaust-Fan Plenums: [Fibrous glass, Type I] [Flexible elastomeric], [1] [1-1/2] [2] <Insert dimension> inch(es thick).
6. Transfer Ducts: [Fibrous glass, Type I] [Flexible elastomeric], [1] [1-1/2] [2] <Insert dimension> inch(es thick).

H. Double-Wall Duct Interstitial Insulation:

1. Supply-Air Ducts: [1] [1-1/2] [2] <Insert dimension> inch(es thick).
2. Return-Air Ducts: [1] [1-1/2] [2] <Insert dimension> inch(es thick).
3. Exhaust-Air Ducts: [1] [1-1/2] [2] <Insert dimension> inch(es thick).

I. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

- 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- J. Branch Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Codes and Standards
 1. SMACNA Standards: Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork.
 2. ASHRAE Standards: Comply with ASHRAE Handbook, Equipment Volume, Chapter 1 "Duct Construction," for fabrication and installation of metal ductwork.
- C. Field Reference Manual: Have available for reference at project field office a copy of SMACNA "HVAC Duct Construction Standards, Metal and Flexible.
- D. Shop Drawings: The sheet metal contractor shall be responsible for the coordination drawings associated with large projects. The lead contractor shall be responsible for ultimate coordination between the other trades with utilities in the ceiling spaces (electric, sprinkler, lighting, plumbing, etc.).
- E. Quality Control: The contractor fabricating and installing the sheet metal work shall be a firm regularly engaged in such work and shall have a minimum of three years of experience.
- F. All ductwork shall meet ANSI/SMACNA 3rd 006-2006, 2005 edition and NEBB air testing requirements. All ductwork shall be tested. Reports are to be turned over to OUA and CxA where applicable.
- G. All duct joints shall be sealed with an approved joint compound to keep leakage below 1%.
- H. Chemical exhaust ductwork shall be tested by an approved testing agency to guarantee duct leakage is below 1% of the design air flow.
- I. All ductwork ends shall be covered during construction until completely connected to minimize debris from entering.
- J. Ductwork shall not pass thru electrical vaults or elevator equipment rooms.

END OF SECTION 233113

KSU DESIGNERS NOTES:

1. Fiberglass ductwork shall not be allowed, however, fabric ductwork, where applicable is allowed subject to OUA review.
2. Due to lower installed costs, round ductwork shall be utilized wherever space allows.
3. Chemical fume hoods types shall be reviewed with the OUA- Engineers. All fume hoods are to be tested to ASHRAE 110-1995, ASHRAE Handbook Applications, SEFA-1 & 1.2-2010, SEFA 8, 9 & 10 Standards and meet NFPA 45-2014 and OSHA 1910.1450 & EPA Guidelines, LABS21 Handbook of Laboratory Safety and ACGIH.
4. Large ductwork shall not be supported from the roof deck unless approved by the structural engineer.
5. Ductwork shall not be installed below grade or under floor slabs unless otherwise approved by OUA.
6. Ductwork shall not pass thru electrical vaults or elevator equipment rooms.
7. Ductwork located outside exposed to weather shall be designed for wind loading, snow and ice loading, and shall be 100% water proof and shall be designed to shed rain water off any horizontal ductwork being installed. Ductwork passing through roof or exterior walls shall have design details and coordinated with project architect. All HVAC designs shall be incorporated with architectural flashing details when applicable.
8. Duct liner:
 - a. Duct liner shall be kept to a minimum on distribution duct supplying terminal control boxes but may be used downstream of the boxes for sound control and insulation. All insulation to be fiber free antimicrobial and comply with UL 181, UL723.
 - b. Duct liner shall be of a non-friable type to prevent entrainment of fiberglass particles in the air stream.
 - c. Projects with commissioning agents shall be required to inspect systems for compliance.
 - d. All duct liner ductwork systems shall be reviewed with OUA. The construction and availability of such a system shall be verified and noted on the construction documents. No substitutions will be allowed. Make sure this system is included under the general conditions and also in the submittal requirements. Associates shall review in detail the construction design intent and cost impact to the project.

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only items relevant to project.

1. Backdraft relief dampers.
2. Pressure relief dampers.
3. Barometric relief dampers.
4. Manual volume dampers.
5. Fire dampers.
6. Ceiling radiation dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Corridor dampers.
10. Flange connectors.
11. Duct silencers.
12. Turning vanes.
13. Remote damper operators.
14. Duct-mounted access doors.
15. Flexible connectors.
16. Duct security bars.
17. Duct accessory hardware.
18. Diffusers, registers, and grilles.
19. Flexible ducts.
20. Louvers.
21. Air intake/exhaust devices.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."
- E. All life safety products to be "FM" Factory Mutual approved.
- F. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets."
- G. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets."
- H. ABC Seal: Provide air outlets and inlets bearing ABC Certified Rating Seal.
- I. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a Mestek Architectural Group company.
 - 2. Cesco Products; a division of MESTEK, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. Ruskin Company.

- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1500 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: Hat-shaped, 24 gage galvanized sheet steel, with welded corners or mechanically attached. Frames and dampers in wet air exhaust shall be stainless steel. Frames and dampers in stainless steel duct shall be stainless steel.
- F. Blades: Multiple single-piece blades, off-center pivoted, maximum 6-inch width, 0.016-inch-thick, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Vinyl.
- I. Blade Axles: Synthetic.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Bearings: Synthetic pivot bushings.
- L. Accessories:

Select from the accessories below.

- 1. Flange mounting [inlet] [and] [outlet].
- 2. Adjustment device to permit setting for varying differential static pressure.
- 3. Counterweights and spring-assist kits for vertical airflow installations.
- 4. Electric actuators.
- 5. Chain pulls.
- 6. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20 gage minimum.
 - b. Sleeve Length: 6 inches minimum.
- 7. Screen Mounting: Rear mounted.
- 8. Screen Material: [Galvanized steel] [Aluminum].
- 9. Screen Type: [Bird] [Insect].
- 10. 90-degree stops.

2.4 PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a Mestek Architectural Group company.
 - 2. Cesco Products; a division of MESTEK, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.

- 5. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: Hat-shaped, 16 gage galvanized sheet steel, with welded corners or mechanically attached. Frames and dampers in wet air exhaust shall be stainless steel. Frames and dampers in stainless steel duct shall be stainless steel.
- F. Blades: Multiple single-piece blades, off-center pivoted, maximum 6-inch width, 0.063-inch-thick, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Vinyl.
- I. Blade Axles: Plated Steel.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Bearings: Galvanized steel press fit or synthetic.
- L. Accessories:

Select from the accessories below.

- 1. Mounting flange on [inlet] [and] [outlet].
- 2. Adjustment device to permit setting for varying differential static pressure.
- 3. Counterweights and spring-assist kits for vertical airflow installations.
- 4. Electric actuators.
- 5. Chain pulls.
- 6. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20 gage minimum.
 - b. Sleeve Length: 6 inches minimum.
- 7. Screen Mounting: Rear mounted.
- 8. Screen Material: [Galvanized steel] [Aluminum].
- 9. Screen Type: [Bird] [Insect].
- 10. 90-degree stops.

2.5 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a Mestek Architectural Group company.
 - 2. Cesco Products; a division of MESTEK, Inc.

3. Greenheck Fan Corporation.
 4. Nailor Industries Inc.
 5. Ruskin Company.
 6. Safe Air - Dowco Products.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 1500 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: Hat-shaped, 16 gage galvanized sheet steel, with welded corners or mechanically attached. Frames and dampers in wet air exhaust shall be stainless steel. Frames and dampers in stainless steel duct shall be stainless steel.
- F. Blades:
1. Multiple, 0.025-inch-thick, roll-formed aluminum.
 2. Maximum Width: 6 inches.
 3. Action: Parallel.
 4. Balance: Gravity.
 5. Eccentrically pivoted.
- G. Blade Seals: Vinyl.
- H. Blade Axles: Plated steel.
- I. Tie Bars and Brackets:
1. Material: Galvanized steel.
 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic.
- L. Accessories:

Select from the accessories below.

1. Flange on [intake] [and] [outlet].
2. Adjustment device to permit setting for varying differential static pressures.

2.6 MANUAL VOLUME DAMPERS

- A. Furnish and install all manual balancing devices, as shown on the drawings or required to properly distribute the air. Unless noted otherwise on the drawings, all manual balancing dampers in ducts with area greater than one square foot shall be the multiple opposed blade type. Balancing dampers in ducts one square foot and smaller may be of a single blade, minimum 18 gage galvanized steel or, duct gage, whichever is heavier. Frames and dampers in

wet air exhaust shall be stainless steel. Frames and dampers in stainless steel duct shall be stainless steel.

B. All accessible manual balancing devices shall be controlled by one of the following:

1. Chrome plated locking nut operators similar to Ventfabrics No. 688.
2. Self-locking lever operators similar to Ventfabrics No. 641.
3. Locking quadrant operators similar to Ventfabrics Nos. 555 and 560.

C. Standard, Steel or Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Warming and Ventilating; a Mestek Architectural Group company.
 - b. Flexmaster U.S.A., Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Frame: Hat-shaped, 16 gage, galvanized sheet steel or 0.10-inch-thick, aluminum sheet channels.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 16 gage thick or 0.050-inch-thick roll formed extruded aluminum.
6. Blade Axles: Plated Steel.
7. Bearings:
 - a. Molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel or aluminum.

2.7 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pottorff.
 2. Ventfabrics, Inc.
 3. Young Regulator Company.
- B. All inaccessible manual balancing devices shall be controlled by remote operators.
- C. Description: Cable system designed for remote manual damper adjustment. Provide with damper, worm gear and cable/flexible shaft with terminations as noted below. Remote cable controlled quadrant shall be factory installed to the damper. Field assembled systems will not be acceptable. Coordinate lengths of cable with installing contractor. Contractor to field cut to length in field.

Select from the options below for remote damper mounting style and finish.

- D. Wall-Box Mounting: [Recessed] [Surface].
- E. Wall-Box Cover-Plate Material: [Steel] [Stainless steel].
- F. Duct or Plenum Mounted.

2.8 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
 2. Nailor Industries Inc.
 3. Pottorff.
 4. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

Select from pressure, velocity and fire ratings below applicable to project.

- C. Closing rating in ducts up to [4] [8] [10]-inch wg static pressure class and minimum [2000] [4000]-fpm velocity.
- D. Fire Rating: [1-1/2] [and] [3] hours as noted on drawings.
- E. Frame: Multiple-blade type or Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, in gage required by UL listing, galvanized steel; with mitered and interlocking corners. Frames and dampers in wet air exhaust shall be stainless steel. Frames and dampers in stainless steel duct shall be stainless steel.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 20 gauge thick and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, minimum 16 gage thick, galvanized sheet steel.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

Select from the options from either of the two sections below. 165 deg F fusible links are standard.

- J. Heat-Responsive Device: Replaceable, [165 deg F] [212 deg F] [286 deg F] rated, fusible links.
- K. Heat-Responsive Device: [Electric] [resettable] [replaceable] link and switch package, factory installed, [165 deg F] [and] [212 deg F] [286 deg F] rated.

2.9 CEILING RADIATION DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Nailor Industries Inc.
 - 3. Pottorff.
 - 4. Ruskin Company.
- B. General Requirements: Comply with the construction details for the tested floor/roof-ceiling assemblies as indicated in the UL Fire Resistance Directory. Provide mineral wool or refractory ceramic thermal blanket where required to protect back of ceiling device and ceiling opening.
 - 1. Labeled according to UL 555C by an NRTL.
 - 2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
- C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- D. Blades: Galvanized sheet steel with refractory insulation.

Select from link and fire ratings below applicable to project. 165 deg F fusible links are standard.

- E. Heat-Responsive Device: Replaceable, [165 deg F] [212 deg F] rated, fusible links.
- F. Fire Rating: [1] [2] [3] hours as indicated on the drawings.

2.10 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Nailor Industries Inc.
 - 3. Pottorff.
 - 4. Ruskin Company.

- B. General Requirements: UL-labeled according to UL Standard 555S by an NRTL, "Standard for Leakage Rated Dampers for Use in Smoke Control Systems". Combination fire and smoke dampers shall also be UL-labeled for 1-1/2 hour or 3 hour rating as indicated, according to UL Standard 555 "Standard for Fire Dampers".

Select from pressure, velocity and fire ratings below applicable to project.

- C. Closing rating in ducts up to [4] [8]-inch wg static pressure class and minimum [2000] [4000]-fpm velocity.
- D. Frame: Hat-shaped, 16 gage, galvanized sheet steel, with integral overlapping gusseted reinforcements in each corner to assure square and provide maximum resistance to racking. Frames and dampers in wet air exhaust shall be stainless steel. Frames and dampers in stainless steel duct shall be stainless steel.
- E. Blades: Roll-formed, horizontal, 16 gage thick, galvanized sheet steel. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper.
- F. Leakage: Leakage and Temperature Ratings: Shall be UL555S Class II - 350 deg F for dampers in 2" w.g. class ductwork and under, and Class I - 350 deg F with airfoil blades for dampers in ductwork with higher than 2" w.g. pressure classification.
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Damper Motors: Two-position action.
- I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 6. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

Coordinate voltage below with electrical engineer.

7. Electrical Connection: [115 V, single phase, 60 Hz] [24V].
- J. Accessories:

Select from the options below for accessories.

1. Auxiliary switches for [signaling] [fan control] [or] [position indication].
2. [Momentary test switch] [Test and reset switches], [damper] [remote] mounted.

2.11 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
 2. Nailor Industries Inc.
 3. Pottorff.
 4. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

Select from pressure, velocity and fire ratings below applicable to project.

- C. Closing rating in ducts up to [4] [8]-inch wg static pressure class and minimum [2000-fpm] [3000-fpm] [4000-fpm] velocity.
- D. Fire Rating: [1-1/2] [and] [3] hours as noted on the drawings.
- E. Frame: Hat-shaped, 16 gage, galvanized sheet steel, with integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking. Frames and dampers in wet air exhaust shall be stainless steel. Frames and dampers in stainless steel duct shall be stainless steel.

Select from heat responsive device options and coordinate with Owner for standards.

- F. Heat-Responsive Device: [Resettable] [Replaceable], [165 deg F] [212 deg F] rated, [fusible links] [fire-closure device].
- G. Heat-Responsive Device: Electric resettable [link] [device] and switch package, factory installed, rated.
- H. Blades: Roll-formed, horizontal, 16 gage thick, galvanized sheet steel. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper.
- I. Leakage: Leakage and Temperature Ratings: Shall be UL555S Class II - 350 deg F for dampers in 2" w.g. class ductwork and under, and Class I - 350 deg F with airfoil blades for dampers in ductwork with higher than 2" w.g. pressure classification.
- J. Rated pressure and velocity to exceed design airflow conditions.
- K. Mounting Sleeve: Factory-installed, 18 gage thick, galvanized sheet steel; length to suit wall or floor application.
- L. Damper Motors: Two-position action.

- M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
6. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

Coordinate voltage below with electrical engineer.

7. Electrical Connection: [115 V, single phase, 60 Hz] [24V].

- N. Accessories:

Select from the options below for accessories.

1. Auxiliary switches for [signaling] [fan control] [or] [position indication].
2. [Momentary test switch] [Test and reset switches] [damper] [remote] mounted.

2.12 CORRIDOR DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Pottorff.
4. Ruskin Company.

- B. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1-hour or 1-1/2-hour rating by an NRTL.

Select from heat responsive devices below applicable to project. 165 deg F fusible links are standard.

- C. Heat-Responsive Device: Replaceable, [165 deg F] [212 deg F] rated, fusible links.
- D. Heat-Responsive Device: Electric resettable [link] [device] and switch package, factory installed, rated.

- E. Frame: Hat-shaped, 16 gage, galvanized sheet steel, with integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking. Frames and dampers in wet air exhaust shall be stainless steel. Frames and dampers in stainless steel duct shall be stainless steel..
- F. Blades: Roll-formed, horizontal, 16 gage thick, galvanized sheet steel. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper.
- G. Mounting Sleeve: Factory-installed, 18 gage thick, galvanized sheet steel; length to suit wall or floor application.
- H. Damper Motors: Two-position action.
- I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 6. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

Coordinate voltage below with electrical engineer.

- 7. Electrical Connection: [115 V, single phase, 60 Hz] [24V].

2.13 FLANGE CONNECTORS

- A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- B. Material: Galvanized steel.
- C. Gage and Shape: Match connecting ductwork.

2.14 DUCT SILENCERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Industrial Noise Control, Inc.
 2. Price Noise Control.
 3. Ruskin Company.
 4. Vibro-Acoustics.
- B. General Requirements:
1. Factory fabricated.
 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Shape:
1. Rectangular straight with splitters or baffles.
 2. Round straight with center bodies or pods.
 3. Rectangular elbow with splitters or baffles.
 4. Round elbow with center bodies or pods.
 5. Rectangular transitional with splitters or baffles.
- D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.034 inch thick.
- E. Round Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel.
1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
 2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
 3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.05 inch thick.
 4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.
- F. Inner Casing and Baffles: ASTM A 653/A 653M, G90 galvanized sheet metal, 22 gage thick, and with 1/8-inch-diameter perforations.
- G. Special Construction:
1. Suitable for outdoor use.
 2. High transmission loss to achieve STC 45 where scheduled.
- H. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- I. Principal Sound-Absorbing Mechanism:
1. Controlled impedance membranes and broadly tuned resonators without absorptive media.

Select from the options below.

2. **[Dissipative]** **[Film-lined]** type with fill material.
 - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression.
 - b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
 3. Lining: **[None]** **[Tedlar]**.
- J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
1. Joints: Lock formed and sealed.
 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 3. Reinforcement: Cross or trapeze angles for rigid suspension.
- K. Accessories:
1. Factory-installed end caps to prevent contamination during shipping.
- L. Source Quality Control: Test according to ASTM E 477.
1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
 2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.
- M. Submittals:
1. Provide acoustical system calculations for all duct systems with silencers to demonstrate that the resultant ductborne sound levels of the equipment as measured in the occupied spaces meet the specified criteria. In the absence of specified background sound level criteria, the guidelines as expressed in Table 34 of Chapter 47, "Sound and Vibration Control" of the 2003 ASHRAE Handbook - HVAC Applications, shall be used.
 2. The manufacturer shall supply certified test data for each scheduled silencer. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same silencer.
 3. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance must have been substantiated by laboratory testing according to ASTM E-477-99 and so certified when submitted for approval. The aero-acoustic laboratory must be NVLAP accredited for the ASTM E-477-99 test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.
- N. Capacities and Characteristics – See schedule on drawings.
- 2.15 TURNING VANES
- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall.

2.16 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a Mestek Architectural Group company.
 - 2. Cesco Products; a division of MESTEK, Inc.
 - 3. Ductmate Industries, Inc.
 - 4. Greenheck Fan Corporation.
 - 5. Nailor Industries Inc.
 - 6. Ruskin Company.
- B. Furnish and install access doors in sheet metal ductwork of size and type as shown on the drawings. Access doors to be factory insulated for insulated ductwork. Access doors shall have flush frames for uninsulated or lined ductwork and shall have extended frames for externally insulated ductwork equal to insulation thickness. All access doors larger than 12" in any dimension shall be hinged, except where obstructed by other services or ceilings. Other access doors shall be cam lock type. All access doors must be fitted for airtight closure and shall be easily opened and closed.
- C. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

RETAIN BELOW ONLY if required on project. Typically \$400-500 per door.

- D. Pressure Relief Access Doors:
 - 1. Access doors downstream of fire or smoke dampers shall be of the negative pressure relief type.
 - 2. Door and Frame Material: Galvanized sheet steel.
 - 3. Door: Single wall for uninsulated ducts or double wall with insulation fill for insulated ducts with metal thickness applicable for duct pressure class.
 - 4. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

Select pressure relief setpoint / range below.

- 5. Factory set at [3.0- to 8.0-inch wg] [10-inch wg].
- 6. Doors close when pressures are within set-point range.
- 7. Hinge: Continuous piano.
- 8. Latches: Cam.
- 9. Seal: Neoprene or foam rubber.

10. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.17 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.
 2. CL WARD & Family Inc.
 3. Ductmate Industries, Inc.
 4. Flame Gard, Inc.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.18 FLEXIBLE CONNECTORS

- A. Provide flexible duct connections where shown on the Drawings, and wherever ductwork connects to vibration isolated equipment. Construct flexible connections of flameproof fabric crimped into duct stripes or flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment. Metal connection material to match duct material.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches or 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

Delete types of flexible connections not utilized.

- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd.
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd..
 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F.
- H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd..
 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F.
- I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.19 DUCT SECURITY BARS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AJ Manufacturing.
 2. Carnes Company.
 3. Kees, Inc.
 4. Price Industries.
 5. Titus.

Select from options below when duct security bars are necessary.

- B. Description: **[Field-fabricated]** **[Factory-fabricated and field-installed]** **[Field- or factory-fabricated and field-installed]** duct security bars.
- C. Configuration:

1. Frame: [2 by 1/4 inch flat frame] [2-1/2 by 2-1/2 by 1/4 inch angle] <Insert values>.
2. Sleeve: [0.1345-inch] [3/16-inch] <Insert size>, [continuously welded] [bent] steel frames with [1-by-1-by-3/16-inch] [1-1/2-by-1-1/2-by-1/8-inch] <Insert size> angle frame [factory welded to 1 end] [furnished loose for field welding on other end]. To be poured in place or set with concrete block or welded or bolted to wall, one side only. Duct connections on both sides.
3. Horizontal Bars: [1/2 inch] [2 by 1/4 inch] <Insert values>.
4. Vertical Bars: [1/2 inch] [3/4 inch] [1 inch] [2 by 1/4 inch] <Insert value>.
5. Bar Spacing: [6 inches] <Insert value>.
6. Mounting: [Metal deck or roofing] [Bolted or welded] [Bolted or welded with masonry anchors] [Ductwork or other framing] [Poured in place or set with concrete block] [Welded or bolted to one wall (one side only)] [Bar extends 6 inches into wall].

2.20 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.21 FLEXIBLE DUCTS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ATCO Rubber Products, Inc.
 2. Flexmaster U.S.A., Inc.
 3. McGill AirFlow LLC.
 4. Thermaflex; a Flex-Tek Group company.
 5. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Non-Insulated, Flexible Duct: UL 181, Class 1, rated for a maximum air velocity of 4000 fpm.
 1. Two-ply vinyl film supported by helically wound, spring-steel wire.
 - a. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - b. Temperature Range: Minus 10 to plus 160 deg F.
 2. Black polymer film supported by helically wound, spring-steel wire.
 - a. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - b. Temperature Range: Minus 20 to plus 175 deg F.
 3. Multiple layers of aluminum laminate supported by helically wound, spring-steel wire.
 - a. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

- b. Temperature Range: Minus 20 to plus 210 deg F.
 - 4. Aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
 - a. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - b. Temperature Range: Minus 20 to plus 210 deg F.
- C. Insulated, Flexible Duct: UL 181, Class 1, rated for a maximum air velocity of 4000 fpm.
 - 1. Two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - a. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - b. Temperature Range: Minus 10 to plus 160 deg F.
 - c. Insulation R-Value: R6 in exterior, attic, and unconditioned spaces. R4.2 in all other spaces.
 - 2. Black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - a. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - b. Temperature Range: Minus 20 to plus 175 deg F.
 - c. Insulation R-Value: R6 in exterior, attic, and unconditioned spaces. R4.2 in all other spaces.
 - 3. Multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - a. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - b. Temperature Range: Minus 20 to plus 210 deg F.
 - c. Insulation R-Value: R6 in exterior, attic, and unconditioned spaces. R4.2 in all other spaces.
 - 4. Aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - a. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - b. Temperature Range: Minus 20 to plus 210 deg F.
 - c. Insulation R-Value: R6 in exterior, attic, and unconditioned spaces. R4.2 in all other spaces.

2.22 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or heavy-duty nylon adjustable self-locking strap in sizes 3 through 18 inches, to suit duct size.

2.23 AIR DIFFUSERS, REGISTERS AND GRILLES:

- A. General: Except as otherwise indicated, provide manufacturer's standard air diffusers, registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide air diffusers, registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data and as scheduled on the drawings.
- C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
- D. Appearance: Diffusers, registers, and grilles which are not similar in appearance to model numbers specified will be rejected.
- E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carnes Co.
 - 2. Krueger Mfg. Co.
 - 3. Price Co.
 - 4. Titus Products Div.; Phillips Industries, Inc.

2.24 LOUVERS:

Review with Architect to coordinate who will furnish and install louvers for project. Coordinate if sight-proof louvers are required. If multiple section louver is used, check with manufacturer to see if concealed mullions are available.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airolite Co.
 - 2. American Warming
 - 3. Construction Specialties Inc.
 - 4. Dowco
 - 5. Greenheck
 - 6. Ruskin
- B. General: Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- C. Performance: Provide louvers that have visual characteristics, minimum free area, maximum water penetration and maximum pressure drop for each type as listed in manufacturer's current data, complying with louver schedule.

- D. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.
- E. Materials: Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners. Louvers consisting of multiple sections shall be provided with concealed mullions unless noted otherwise on Drawings. Provide finish as indicated on the Drawings.

Edit above and below to suit project requirements.

- F. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

2.25 AIR INTAKE/EXHAUST DEVICES:

Specify items such as roof or wall jacks with the fans they are serving, not in this section. Retain relevant items below and coordinate who will select the color.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airolite Co.
 - 2. Carnes Co.
 - 3. Greenheck
 - 4. Loren Cook Co.
- B. Louvered Penthouses: Shall be constructed of storm-proof aluminum louvers with mitered corners. Top cover shall be configured to prevent moisture build-up, and shall be lined with fiberglass to prevent condensation. Furnish with birdscreen and matching insulated aluminum roof curb. Coordinate roof curb height to maintain roof manufacturer system (minimum 12-16"). Furnish in baked enamel finish with color as selected by **[Architect] [Engineer]**.
- C. Gravity Type Spun Aluminum Ventilators: Shall be constructed of heavy gauge aluminum with a formed edge for additional strength. Cover shall be detachable. Furnish with perimeter windband, aluminum birdscreen and matching insulated aluminum roof curb. Furnish in baked enamel finish with color as selected by **[Architect] [Engineer]**.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Examine areas and conditions under which metal ductwork and accessories are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

- B. Drawings show the general layout of ductwork and accessories, but do not necessarily show all required fittings and offsets that may be necessary to connect ducts to equipment, terminal units, diffusers, etc. and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the Owner. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grids where applicable. Duct sizes on drawings are external sizes which shall be altered by contractor (with approval of Engineer) to other dimensions with the same or better area and friction characteristics where necessary to avoid interferences and clearance difficulties.
- C. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- D. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- E. Compliance with ASHRAE/IESNA 90.1-2004 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain applications. Install backdraft or control dampers as indicated at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- F. Install volume dampers where indicated on the drawings at points on supply, return, and exhaust systems where branches extend from larger ducts or as required to provide adequate means of adjusting air flow. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
 - 3. Regulators: Install regulators on all manual balancing devices. If ductwork is accessible, mount the regulator on the ductwork. If ductwork will be inaccessible after the installation of the ceiling or walls, regulators shall be mounted in a steel, flush mounted box specifically designed for this purpose. Provide all linkage, top bearings and/or gear drives required for the remote installation of the regulator.
- G. Set dampers to fully open position before testing, adjusting, and balancing.
- H. Temperature Control Dampers: Install all temperature control dampers where indicated on the drawings unless factory installed in air handling equipment.
 - 1. Provide necessary transitions required to install dampers larger than duct size. Do not install control dampers smaller than duct size.
 - 2. Assemble multiple section dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
 - 3. See drawings for furnishing recommendation for temperature control dampers.
- I. Turning Vanes: Install turning vanes in square or rectangular 90 degree elbows in supply air systems, and elsewhere as indicated.
- J. Install test holes at fan inlets and outlets and elsewhere as indicated.

- K. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and 1/2-inch-diameter steel bars, 6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.
- L. Connect ducts to duct silencers rigidly.
- M. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. On both sides of duct coils.
 2. Upstream and downstream from duct filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from control dampers, backdraft dampers, and equipment.
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. Control devices requiring inspection.
 8. Elsewhere as indicated.
- N. Install access doors with swing against duct static pressure.
- O. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- P. Install flexible connectors to connect ducts to equipment.
- Q. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- R. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- S. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- T. Connect flexible ducts to metal ducts with draw bands and tape to adjoining duct surface.
- U. Install duct test holes where required for testing and balancing purposes.
- V. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 INSTALLATION OF FIRE DAMPERS

- A. Fire Dampers: Install in accordance with details on drawings, manufacturer's written instructions and requirements of UL classification, in all ductwork and air openings passing through fire rated walls and partitions as shown on the drawings or as required by Code. Dampers rating, use and frame style shall be as indicated on drawings. Provide access doors as required for visual inspection of fire damper, maintenance and fusible link repair/replacement.

3.3 INSTALLATION OF SMOKE DAMPERS

- A. Smoke Dampers: Install in accordance with details on drawings, manufacturer's written instructions and requirements of UL classification, in all ductwork and air openings passing through smoke walls and partitions as shown on the drawings or as required by Code. Provide access doors as required for visual inspection of damper and maintenance.
 - 1. This Contractor shall coordinate with Electrical Contractor for signal wiring, power wiring, and smoke detector furnished and installed by that Contractor.
- B. Combination Fire/Smoke Dampers: Install as indicated for smoke dampers above, in all ductwork passing through fire rated walls and partitions as shown on the drawings or as required by Code, where smoke dampers are also required. Fire damper rating shall be as indicated on drawings.

3.4 INSTALLATION OF SOUND ATTENUATORS

- A. General: Install sound attenuators as indicated on drawings and in schedules, and in accordance with the manufacturer's written instructions.
- B. Location: Install each sound attenuator level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer. Install sound attenuators as close to noise source as possible.
- C. Duct Connections: Connect ductwork to sound attenuator in accordance with this specification.

3.5 INSTALLATION OF AIR DIFFUSERS, REGISTERS AND GRILLES:

- A. Install air diffusers, registers and grilles in ceilings where indicated in accordance with manufactures instructions and recognized industry practices to insure that products serve intended purpose.
- B. Locate air diffusers, registers and grilles as indicated on architectural "Reflected Ceiling Plans". Unless otherwise indicated, locate units in the center of acoustical ceiling tiles. Install level and plumb.
- C. Install diffusers with airtight connections to duct and to allow service and maintenance of dampers, air extractors, and fire dampers.

- D. Coordinate installation of air diffusers, registers and grilles with other trades installing devices in the ceiling.
- E. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

3.6 INSTALLATION OF FLEXIBLE DUCTS:

- A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Flexible ducts must be furnished as required for pressure classification of ductwork system.
- D. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistant rating of one hour or more.
- E. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- F. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- G. Connect flexible ducts to metal ducts with draw bands. Where heavy duty nylon clamps are used, clamps to be adjustable until tensioned and cut-off with the banding tool. Tape and seal perimeter of flexible ducts to adjoining hard duct.
- H. Install duct test holes where required for testing and balancing purposes.
- I. Installation:
 - 1. Install ducts fully extended.
 - 2. Do not bend ducts across sharp corners.
 - 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
 - 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
 - 5. Install flexible ducts in a direct line, without sags, twists, or turns.
 - 6. Seal all flexible duct insulation ends completely with duct tape.
- J. Supporting Flexible Ducts:
 - 1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
 - 2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
 - 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.

4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

3.7 INSTALLATION OF LOUVERS:

Use one of the following paragraphs after coordinating with Architect. Installation by the mechanical contractor may be more appropriate for renovation projects where sheetmetal contractor may be responsible for cutting and patching associated with installation of their work.

- A. Louvers: Furnish louvers to General Contractor in installation area and coordinate his installation.
- B. Louvers: Install louvers per Architectural and Mechanical Drawings, and per manufacturer's recommendations. Coordinate installation with other trades. Seal around louvers air and watertight.
- C. Coordination: Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.8 INSTALLATION OF AIR INTAKE/EXHAUST DEVICES:

- A. Install air intake/exhaust devices in accordance with manufacturer's written installation instructions. Coordinate installation with other trades. Set units level. Place devices on curb and attach to provide a weathertight installation.

Select one of the following paragraphs. Coordinate curb installation. Coordinate with Architect. First paragraph is preferred when there will be a general trades contractor on the project.

- B. Furnish curbs selected for application to installing contractor in installation area and coordinate his installation.
- C. Install curbs and flash roofing materials as required for a weathertight installation. Roofing procedures shall maintain existing roof materials warranty where applicable.

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.
 5. Operate remote damper operators to verify full range of movement of operator and damper.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Ductwork accessories shall be provided by the sheet metal contractor and therefore all quality assurance and standards listed under that section shall apply to this section.
- C. Balance or volume dampers shall be provided at all branches for balancing purposes.
- D. All damper designs shall include quadrant locking type with ball bearing and nylon sleeves or bushing at duct penetrations. Dampers shall be designed with insulated stem extension when dealing with duct wrap or insulated board. Insulated ductwork shall have the bearing plates extended so that the insulation does not interfere with the damper operation.
- E. Manual dampers shall be installed over public areas whenever possible. When dampers are located over rigid ceilings, the use of gear driven actuators and flexible extensions shall be utilized and prior submittal approval shall be provided by Associate for OUA approval.
- F. Access doors shall be large enough to access and reset fire and/or smoke dampers, but no less than 12" x 12".
- G. Duct access doors with vision windows shall be provided wherever required to maintain equipment in the ductwork including the following:
 - 1. Fire and smoke dampers.
 - 2. Control dampers in order to verify operation.
 - 3. On the inlet side of coils (including air handler coils) for cleaning purposes.
 - 4. At the inlet of in-line fans for cleaning and operation verification.
- H. Connections to equipment shall be made with a flexible duct connection 3" to 4" wide.
- I. Flexible duct connections and flexible air connectors on ductwork shall be UL 181 listed and tested and flexible air connectors shall be rated to Class (0) or Class (1) based on system pressure and shall be installed per OMC to section 304.1. No field made joints will be acceptable for flexible air connectors
- J. Flexible ductwork shall be used for the connection to distribution diffusers where feasible. The use of the flexible duct allows for minor adjustment to the location of the diffuser during future space modifications as well as lowers initial installation costs. 3'-0" maximum horizontal distance and 5'-0" maximum vertical and include no more than 90 degrees (one elbow) of direction change.
- K. Flexible Ductwork shall be taped and clamped sealed to terminal unit's main box and shall also be and clamped and taped to any SA ductwork having wrapped insulation to insure vapor barrier on supply air ductwork is not exposed to conditioned air space.

- L. Flexible ductwork to VAV terminal unit shall be secured and taped tight to terminal unit with no exposed fiberglass edges.

END OF SECTION 233300

KSU DESIGNERS NOTES:

1. Balance or volume dampers shall be provided at all branches for balancing purposes. These dampers should be shown on the drawings. High quality is to be used and shall accommodate insulation thickness where required.
2. Fire dampers shall be out of the air stream type wherever possible.
3. Access shall be provided to all fire and smoke dampers. If damper cannot be reached via a distribution opening, an access door shall be provided.
4. Turning Vanes: Turning vanes shall be installed at all bends in the supply air ductwork unless recommended otherwise by the Architect/Engineer. Return / exhaust ductwork having large volumes or velocity shall have turning vanes.
5. Sound Attenuators – Review requirements with OUA.
6. All roof mounted equipment shall be furnished with full perimeter curbs or rails with flexible vibration isolators. These types of systems shall be reviewed with OUA.
7. In no case can any flexible duct longer than (5'-0") or sock system be longer than 14'-0" be indicated in the design documents without review by OUA.
8. Ceiling diffusers and registers shall be lay-in type whenever possible. This reduces initial installation as well as future renovation costs. Architectural flat plate "plaque" style preferred.
9. Air outlets should be balanced by a manual damper in the ductwork instead of a damper at the diffuser. This minimizes tampering of the balanced system by room occupants and reduces noise.
10. Return air shall be via a return air ceiling whenever possible. Consult with OUA if the return air system will be otherwise. The use of return air ceilings will save both installation and future renovation costs.
11. The University prefers a supply diffuser which the throw directions may be changed in the field with baffles such as the "Plaque Style."
12. Diffuser throw directions and grille/register louvers shall be adjusted to the proper position by the balance contractor. A note should be included in the specifications and on diffuser schedule directing the contractor to perform this final setting.
13. Egg crate type grilles shall not be used for exhaust or return systems due to the difficulty in cleaning. Prefer ½" spacing horizontal blade grilles.
14. Review duct system sound attenuation and special provisions with the OUA. Provide details on any roof mounted equipment so all sound transmission and vibration isolation is accounted for. Roof curbs shall be designed with sound acoustic designs at all locations. NC curves shall be specified. Review all curbs details for sound transmissions with OUA.

SECTION 233413 - AXIAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

Retain only fans applicable to project here and in from Part 2 as well.

1. Tubeaxial fans.
2. Vaneaxial fans.
3. Mixed-flow fans.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Include rated capacities, furnished specialties, and accessories for each fan.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Fan speed controllers.

- B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

B. Seismic Qualification Data: Certificates, for fans, accessories, and components, from manufacturer.

- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.**
- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.**
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.**

- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fans include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- H. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.

Retain below only if belt driven fans are basis of design.

1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective coverage for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual project site elevations

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- B. Seismic Performance: Axial HVAC fans shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7].

- 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event]."
 - 2. Component Importance Factor: [1.5] [1.0].

- C. Capacities and Characteristics: See Schedules on Drawings.
- D. Manufacturers: Subject to compliance with requirements, provide fan products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. Twin City Fans.
- E. Source Limitations: Obtain fans from single manufacturer.

2.2 TUBEAXIAL FANS

Edit below to suite application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select housing construction and wheel assemblies to suit project and systems conveyed by fans.

- A. Description: Fan wheel and housing, factory-mounted motor with [belt] [or] [direct] drive, an inlet cone section, and accessories.
- B. Housings: [Steel] [Galvanized steel] [Aluminum] [Fiberglass-reinforced plastic] [Stainless steel] with flanged inlet and outlet connections.
- C. Wheel Assemblies: Cast or extruded aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.
- D. Wheel Assemblies: Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless-steel shaft.
- E. Wheel Assemblies: Cast aluminum; machined and fitted to shaft.

Retain below only if belt driven motors are used.

- F. Belt Drives:
 - 1. Factory mounted, with adjustable alignment and belt tensioning.
 - 2. Service Factor Based on Fan Motor Size: 1.2.
 - 3. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 - 4. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 - 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 7. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 8. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
 - 9. Shaft Bearings: Radial, self-aligning bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 of 50,000 hours.
 - b. Roller-Bearing Rating Life: ABMA 11, L10 of 50,000 hours.
 - c. Extend lubrication lines to outside of casing and terminate with grease fittings.

G. Accessories:

Select from the accessories below. Items 1-5 are typical. Select from item 6 or 7. Remaining options are project specific. Review with manufacturer.

- 1. Companion Flanges: Rolled flanges of same material as housing.
- 2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
- 3. Mounting Clips: Clips welded to fan housing, of same material as housing.
- 4. Factory-wired motor disconnect switch located on outside of fan housing.

5. Thrust Restraints.
6. Direct-Driven Units: Encase motor in housing outside of airstream. Extend lubrication lines to outside of casing and terminate with grease fittings.
7. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
8. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
9. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
10. Inlet Screen: On unducted fan inlet - wire-mesh screen, of same material as housing.
11. Outlet Screen: On unducted fan outlet - wire-mesh screen, of same material as housing.
12. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
13. Inlet Cone: Round-to-round transition, of same material as housing.
14. Outlet Cone: Round-to-round transition, of same material as housing.
15. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
16. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
17. Shaft Seal: Elastomeric seal and PTFE wear plate, suitable for up to 300 deg F.

H. Factory Finishes:

See description at end of section for paint types and their resistance to chemicals. Select appropriate paint type to suit project and systems conveyed by fans.

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [Epoxy] [Zinc] [Phenolic] [Powder-baked enamel]; <Insert manufacturer's name and trade name>.
 - a. Apply to finished housings.
 - b. Apply to fan wheels.

2.3 VANEAXIAL FANS

Edit below to suite application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select housing construction and wheel assemblies to suit project and systems conveyed by fans.

- A. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with [belt drive] [or] [direct drive], an inlet cone section, and accessories.
- B. Housings: [Steel] [Aluminum] [Fiberglass-reinforced plastic] [Stainless steel] <Insert material>.
 1. Inlet and Outlet Connections: Flanges.
 2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
- C. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

D. Wheel Assemblies: Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless-steel shaft.

E. Wheel Assemblies: Cast-aluminum hub assembly, machined and fitted with threaded bearing wells to receive blade-bearing assemblies with replaceable, cast-aluminum blades; factory mounted and balanced.

Retain below only if belt driven motors are used.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.2.
2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
7. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
8. Shaft Bearings: Radial, self-aligning bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
 - b. Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours.
 - c. Extend lubrication lines to outside of casing and terminate with grease fittings.

G. Accessories:

Select from the accessories below. Items 1-5 are typical. Select from item 6 or 7. Remaining options are project specific. Review with manufacturer.

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Mounting Clips: Clips welded to fan housing, of same material as housing.
4. Factory-wired motor disconnect switch located on outside of fan housing.
5. Thrust Restrains.
6. Direct-Driven Units: Encase motor in housing outside of airstream. Extend lubrication lines to outside of casing and terminate with grease fittings.
7. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
8. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
9. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
10. Inlet Screen: On unducted fan inlet - wire-mesh screen, of same material as housing.
11. Outlet Screen: On unducted fan outlet - wire-mesh screen, of same material as housing.
12. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
13. Inlet Cone: Round-to-round transition, of same material as housing.
14. Outlet Cone: Round-to-round transition, of same material as housing.
15. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.

16. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
17. Shaft Seal: Elastomeric seal and PTFE wear plate, suitable for up to 300 deg F.
18. Stall Alarm Probe: Sensing probe capable of detecting fan operation in stall and signaling control devices.
19. Flow Measurement Port: Pressure measurement taps installed in fan inlet to detect and signal airflow readings to temperature-control systems.

H. Factory Finishes:

See description at end of section for paint types and their resistance to chemicals. Select appropriate paint type to suit project and systems conveyed by fans.

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [Epoxy] [Zinc] [Phenolic] [Powder-baked enamel]; <Insert manufacturer's name and trade name>.
 - a. Apply to finished housings.
 - b. Apply to fan wheels.

2.4 MIXED-FLOW FANS

Edit below to suite application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select housing construction and wheel assemblies to suit project and systems conveyed by fans.

- A. Source Limitations: Obtain mixed-flow fans from single manufacturer.
- B. Description: Fan wheel and housing, factory-mounted motor with [belt drive] [or] [direct drive], and accessories.
- C. Housings: [Steel] [Galvanized steel] [Aluminum].
 1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
 2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
 3. Mixed-Flow Outlet Connection: [One] [Two] flanged discharge(s) perpendicular to fan inlet.
- D. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

Retain below only if belt driven motors are used.

- E. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 1. Service Factor Based on Fan Motor Size: 1.2.
 2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.

4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
7. Shaft Bearings: Radial, self-aligning bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
 - b. Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours.
 - c. Extend lubrication lines to outside of casing and terminate with grease fittings.

F. Accessories:

Select from the accessories below. Items 1-5 are typical. Select from item 6 or 77. Remaining options are project specific. Review with manufacturer.

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Mounting Clips: Clips welded to fan housing, of same material as housing.
4. Factory-wired motor disconnect switch located on outside of fan housing.
5. Thrust Restraint.
6. Direct-Driven Units: Encase motor in housing outside of airstream.
7. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
8. Inlet and Outlet Screens: On unducted fan inlet and outlet - wire-mesh screen, of same material as housing.
9. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
10. Inlet Cones: Round-to-round transition, of same material as housing.
11. Outlet Cones: Round-to-round transition, of same material as housing.
12. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.

G. Factory Finishes:

See description at end of section for paint types and their resistance to chemicals. Select appropriate paint type to suit project and systems conveyed by fans.

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [Epoxy] [Zinc] [Phenolic] [Powder-baked enamel]; <Insert manufacturer's name and trade name>.
 - a. Apply to finished housings.
 - b. Apply to fan wheels.

2.5 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. AMCA Compliance:
 - 1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
- C. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans in accordance with AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- D. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install axial fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:

Select from the two paragraphs below. First paragraph is for projects with Seismic requirements.

- 1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

- E. Install units with adequate clearances for service and maintenance.
- F. Label fans in accordance with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- G. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.2 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.3 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Fans and components will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE:

- A. Perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. For direct-drive fans, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
 - 6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 7. Adjust belt tension.
 - 8. Adjust damper linkages for proper damper operation.
 - 9. Verify lubrication for bearings and other moving parts.
 - 10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 12. Shut unit down and reconnect automatic temperature-control operators.

13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain axial HVAC fans.

END OF SECTION 233413

KSU DESIGNERS NOTES:

1. Preferred Manufacturers: Loren Cook – Preferred, Greenheck, Twin City, Lab exhaust - Twin City, Strobic, Loren Cook, All equivalents as approved by OUA
2. Motor sizes to be selected for NON-OVERLOADING condition so as to prevent nuisance trips.
3. University preference is NOT to use Vaneaxial or Tube Axial Fans. Coordinate with OUA Engineer before basing project on either of these types.
4. Direct drive assemblies are preferred over belt driven motors to minimize maintenance and belt losses.
5. Exhaust fans with 3 phase motors may be belt driven. Belt driven fans shall incorporate cogged v-belts or synchronous drive belts on 10 MHP and above to reduce drive losses when installed without a VFD.
6. Green technology toilet exhaust fans with direct drive, electrically commutated motors and speed control shall be considered to minimize campus maintenance requirements.
7. All exhaust fans shall have means of disconnecting power to drive unit externally located at or close to the unit. Disconnect switches to be on the outside of the fan.

8. Control toilet room exhaust system with occupancy sensor controls and/or through the BAS when applicable. Review with KSU OUA.
9. Roof mounted fans with dampers, gravity or motorized, shall be installed with access to the damper via a hinged mounting or with access doors.
10. Review all exhaust fan applications with the use of energy recovery coils and systems.
11. Kitchen exhausts fans and curbs to be reviewed with OUA.
12. Lab Exhaust Fans: Strobic or Twin City vertical discharge fan with louvered curb housing if budget allows. Associate to review coating requirements for lab application. All lab exhaust systems to discharge minimum 7'-0" above roof line or per applicable code.
13. See links below to typical coatings available for Greenheck and Cook. These go in great detail of chemical resistance of each of coating to various chemicals.
http://www.lorencook.com/PDFs/Catalogs/Coatings_Brochure.pdf
http://www.adehvac.com/uploads/application/files/greenheck_coating_application.pdf
14. Per ASHRAE 90.1-2010 all outdoor air and exhaust air systems shall be equipped with motorized dampers that will automatically shut when the systems are not in use. Backdraft dampers are only acceptable in systems with an outdoor air intake or exhaust capacity of 300 cfm or less.

SECTION 233416 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

Retain only fans applicable to project here and in from Part 2 as well.

- A. Section Includes:

1. Backward-inclined centrifugal fans, including airfoil and curved blade fans.
2. Forward-curved centrifugal fans.
3. Square in-line centrifugal fans.
4. Tubular in-line centrifugal fans.
5. Plenum fans.
6. Plug fans.
7. Utility set fans.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.

- B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Fan room layout and relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

- G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- H. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

Retain paragraph below only if belt driven fans are specified.

1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual project site elevations.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- B. Seismic Performance: Centrifugal fans shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7].
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
 - 2. Component Importance Factor: [**1.5**] [**1.0**].

- C. Capacities and Characteristics: See Schedules on Drawings.
- D. Manufacturers: Subject to compliance with requirements, provide fan products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. Twin City Fans.
- E. Source Limitations: Obtain fans from single manufacturer.

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select wheel assemblies to suit project and systems conveyed by fans.

- A. Description:
 - 1. Factory-fabricated, -assembled, -tested, and -finished, [~~belt-~~][direct-]driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 - 2. Factory-installed and -wired disconnect switch.
- B. Housings:
 - 1. Housing Material: [Reinforced steel] [Shaped fiberglass-reinforced plastic] [Aluminum] [Stainless steel] [See schedule] <Insert material>.
 - 2. Housing Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
 - 3. Housing Assembly: Sideplates[continuously welded][or][spot welded][or][attached by continuous Pittsburgh lock seal or similar seal].
 - 4. Formed panels to make curved-scroll housings with shaped cutoff.
 - 5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 6. Horizontally split, bolted-flange housing.
 - 7. Spun inlet cone with flange.
 - 8. Outlet flange.
 - 9. Discharge Arrangement: Fan scroll housing is field rotatable to any of [seven] [eight] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.
- C. Wheels:
 - 1. Wheel Configuration: [SWSI] [DWDI] construction with a precision-spun curved inlet flange and a backplate fastened to shaft with setscrews. Wheels shall be statically and dynamically balanced, and nonoverloading.
 - 2. Wheel and Blade Material: [Steel] [Aluminum] [One-piece fiberglass-reinforced plastic] [Stainless steel] [See schedule].

- a. Spark-Resistant Construction: Classified according to AMCA 99, [Type A] [Type B] [Type C].
 3. Wheel and Blade Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
 4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
 5. Backward-Inclined Airfoil Blades:
 - a. Aerodynamic design.
 - b. Heavy backplate.
 - c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
 6. Backward-Inclined Curved Blades:
 - a. Curved design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded at tip flange and backplate.
- D. Shafts:
1. Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Bearings:
1. Prelubricated and Sealed Shaft Bearings:
 - a. Self-aligning, pillow-block-type ball bearings.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 100,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
 2. Grease-Lubricated Shaft Bearings, Tapered Roller:
 - a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - b. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
 - c. Extended Lubrication Lines: Extend lines to accessible location.
 3. Grease-Lubricated Shaft Bearings, Ball or Roller:
 - a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 100,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
 - d. Extended Lubrication Lines: Extend lines to accessible location.

Retain below only if belt driven motors are used.

F. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.2.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch pulleys for use with motors larger than 5 hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; **[0.146 inch-] <Insert dimension>** thick, **[3/4-inch] <Insert dimension>** diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

G. Motor Enclosure: **[Open, dripproof] [Totally enclosed, fan cooled] [Explosion proof] <Insert motor enclosure type>**.

Retain option below for EC Motor option. Note these are limited in size of motor and voltages. Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial or 0-10-VDC signal. Review availability with manufacturer.

H. EC Motor:

1. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be a minimum of 85% efficient at all speeds.
 - a. Speed shall be controlled by:
 - 1) A potentiometer dial mounted on the motor
 - 2) A 0-10 VDC signal.

I. Accessories:

Select from the accessories below. Items 1-5 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.

4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
6. Discharge Dampers: Assembly with [parallel] [opposed] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
7. Inlet Screens: Grid screen of same material as housing.
8. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.3 FORWARD-CURVED CENTRIFUGAL FANS

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select wheel assemblies to suit project and systems conveyed by fans.

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [belt-] [direct-] driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

B. Housings:

1. Housing Material: [Reinforced steel] [Shaped fiberglass-reinforced plastic] [Aluminum] [Stainless steel] [See schedule].
2. Housing Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
3. Housing Assembly: Sideplates [continuously welded] [or] [spot welded] [or] [attached by continuous Pittsburgh lock seal or similar seal].
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Horizontally split, bolted-flange housing.
7. Spun inlet cone with flange.
8. Outlet flange.
9. Discharge Arrangement: Fan scroll housing field rotatable to any of [seven] [eight] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

C. Wheels:

1. Wheel Configuration: [SWSI] [DWDI] construction with a curved inlet flange, and a backplate fastened to shaft with setscrews.
2. Wheel and Blade Material: [Steel] [Aluminum] [One-piece fiberglass-reinforced plastic] [Stainless steel] [See schedule].

- a. Spark-Resistant Construction: Classified according to AMCA 99, [Type A] [Type B] [Type C].
- 3. Wheel and Blade Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
- 4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with setscrews.
- 5. Forward-Curved Wheels:
 - a. Black-enameled or galvanized-steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow.
 - b. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with setscrews.

D. Shafts:

- 1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
- 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
- 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Bearings:

- 1. Prelubricated and Sealed Shaft Bearings:
 - a. Self-aligning, pillow-block-type [ball] [roller] bearings.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 100,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
- 2. Grease-Lubricated Shaft Bearings, Tapered Roller:
 - a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - b. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
 - c. Extended Lubrication Lines: Extend lines to accessible location.
- 3. Grease-Lubricated Shaft Bearings, Ball or Roller:
 - a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 100,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
 - d. Extended Lubrication Lines: Extend lines to accessible location.

Retain below only if belt driven motors are used.

F. Belt Drives:

- 1. Factory mounted, with adjustable alignment and belt tensioning.
- 2. Service Factor Based on Fan Motor Size: 1.2.

3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [0.146 inch-] <Insert dimension> thick, [3/4-inch] <Insert dimension> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

G. Motor Enclosure: [Open, dripproof] [Totally enclosed, fan cooled] [Explosion-proof].

Retain option below for EC Motor option. Note these are limited in size of motor and voltages (typically 120V on motors up to 3/4 HP). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

H. EC (Electrically Commutated) Motor:

1. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be a minimum of 85% efficient at all speeds.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

Retain option below for PM Motor option. Note these are limited in size of motor and voltages (less than 30 HP but available in multiple voltages). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

I. PM (Permanent Magnet) Motor:

1. Units to utilize a variable torque Permanent Magnet (PM) motor with separate motor controller. Controller is factory installed, wired and programmed for the maximum rpm based on the actual fan selection.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

J. Accessories:

Select from the accessories below. Items 1-5 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
6. Discharge Dampers: Assembly with [parallel] [opposed] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
7. Inlet Screens: Grid screen of same material as housing.
8. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.4 SQUARE IN-LINE CENTRIFUGAL FANS

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select wheel assemblies to suit project and systems conveyed by fans.

A. Description: Square in-line centrifugal fans.

B. Housing:

1. Housing Material: [Reinforced steel] [Aluminum] [Stainless steel] [See schedule] <Insert material>.

2. Housing Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

Select from the two options below for Direct or Belt driven.

- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[; with wheel, inlet cone, and motor on swing-out service door].
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.
- F. Motor Enclosure: [Open, dripproof] [Totally enclosed, fan cooled] [Explosion-proof] <Insert motor enclosure type>.

Retain option below for EC Motor option. Note these are limited in size of motor and voltages (typically 120V on motors up to 3/4 HP). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

- G. EC (Electrically Commutated) Motor:
 1. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be a minimum of 85% efficient at all speeds.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

Retain option below for PM Motor option. Note these are limited in size of motor and voltages (less than 30 HP but available in multiple voltages). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

H. PM (Permanent Magnet) Motor:

1. Units to utilize a variable torque Permanent Magnet (PM) motor with separate motor controller. Controller is factory installed, wired and programmed for the maximum rpm based on the actual fan selection.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

I. Accessories:

Select from the accessories below. Items 1-2 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
3. Insulated housing: An acoustical lining is available for the interior of the SQI. This fiberglass duct liner provides a reduction in noise of approximately 3dB in each of the eight octave bands.
4. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
5. Companion Flanges: For inlet and outlet duct connections.
6. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
7. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
8. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

2.5 TUBULAR IN-LINE CENTRIFUGAL FANS

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select wheel assemblies to suit project and systems conveyed by fans.

A. Description: Tubular in-line centrifugal fans.

B. Housing:

1. Housing Material: [Reinforced steel] [Shaped fiberglass-reinforced plastic] [Aluminum] [Stainless steel] [See schedule] <Insert material>.

2. Housing Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
3. Housing Construction: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

Select from the two options below for Direct or Belt driven.

- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[; with wheel, inlet cone, and motor on swing-out service door].
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: [Steel] [Aluminum], airfoil blades welded to aluminum hub.
- F. Motor Enclosure: [Open, dripproof] [Totally enclosed, fan cooled] [Explosion-proof] <Insert motor enclosure type>.

Retain option below for EC Motor option. Note these are limited in size of motor and voltages (typically 120V on motors up to 3/4 HP). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

G. EC (Electrically Commutated) Motor:

1. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be a minimum of 85% efficient at all speeds.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

Retain option below for PM Motor option. Note these are limited in size of motor and voltages (less than 30 HP but available in multiple voltages). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

H. PM (Permanent Magnet) Motor:

1. Units to utilize a variable torque Permanent Magnet (PM) motor with separate motor controller. Controller is factory installed, wired and programmed for the maximum rpm based on the actual fan selection.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

I. Accessories:

Select from the accessories below. Items 1-2 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
3. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
4. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
5. Companion Flanges: For inlet and outlet duct connections.
6. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
7. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.6 PLENUM FANS

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select wheel assemblies to suit project and systems conveyed by fans.

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [~~belt~~] [~~direct~~]-driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. [Factory-installed and -wired disconnect switch.]

B. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: [Steel] [Aluminum] [One-piece fiberglass-reinforced plastic] [Stainless steel] [See schedule].
 - a. Spark-Resistant Construction: Classified according to AMCA 99, [Type A] [Type B] [Type C].
3. Wheel and Blade Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

C. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

D. Bearings:

1. Prelubricated and Sealed Shaft Bearings:
 - a. Self-aligning, pillow-block-type ball bearings.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 100,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
2. Grease-Lubricated Shaft Bearings, Tapered Roller:
 - a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - b. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
 - c. Extended Lubrication Lines: Extend lines to accessible location.
3. Grease-Lubricated Shaft Bearings, Ball or Roller:
 - a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 100,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
 - d. Extended Lubrication Lines: Extend lines to accessible location.

Retain below only if belt driven motors are used.

E. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.2.

3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate to SMACNA's "HVAC Duct Construction Standards"; **[0.146 inch-] <Insert dimension> thick, [3/4-inch]** diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

F. Motor Enclosure: **[Open, dripproof] [Totally enclosed, fan cooled] [Explosion proof]**.

G. Accessories:

Select from the accessories below. Items 1-2 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Inlet Safety Screen: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
3. Safety Enclosure: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
4. Belt Guard: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
5. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.7 PLUG FANS

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select wheel assemblies to suit project and systems conveyed by fans.

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

B. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: [Steel] [Aluminum] [One-piece fiberglass-reinforced plastic] [Stainless steel] [See schedule].
 - a. Spark-Resistant Construction: Classified according to AMCA 99, [Type A] [Type B] [Type C].
3. Wheel and Blade Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

C. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

D. Bearings:

1. Prelubricated and Sealed Shaft Bearings:
 - a. Self-aligning, pillow-block-type ball bearings.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 100,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
2. Grease-Lubricated Shaft Bearings, Tapered Roller:
 - a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 100,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
 - d. Extended Lubrication Lines: Extend lines to accessible location.
3. Grease-Lubricated Shaft Bearings, Ball or Roller:
 - a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 100,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 100,000 hours.
 - d. Extended Lubrication Lines: Extend lines to accessible location.

Retain below only if belt driven motors are used.

E. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.2.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with larger motors.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; **[0.146 inch-] <Insert dimension>** thick, **[3/4-inch] <Insert dimension>** diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

F. Motor Enclosure: **[Open, dripproof] [Totally enclosed, fan cooled] [Explosion-proof]**.

G. Accessories:

Select from the accessories below. Items 1-2 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Inlet Safety Screen: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
3. Safety Enclosure: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
4. Belt Guard: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
5. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.8 UTILITY SET FANS

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select wheel assemblies to suit project and systems conveyed by fans.

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, **[belt-] [direct-]** driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

B. Housings:

1. Housing Material: [Reinforced steel] [Shaped fiberglass-reinforced plastic] [Aluminum] [Stainless steel] [See schedule] <Insert material>.
2. Housing Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
3. Formed panels to make curved-scroll housings with shaped cutoff.
4. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
5. Discharge Arrangement: Fan scroll housing field rotatable to any of [seven] [eight] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

C. Wheels:

1. Wheel Configuration: SWSI, with hub keyed to shaft.
2. Wheel and Blade Materials: [Steel] [Aluminum] [One-piece fiberglass-reinforced plastic] [Stainless steel] [See schedule].
 - a. Spark-Resistant Construction: Classified according to AMCA 99, [Type A] [Type B] [Type C].
3. Wheel and Blade Coating: [None] [Thermoplastic vinyl] [Epoxy] [Synthetic resin] [Phenolic] [Hot-dip galvanized] [Powder-baked enamel] [See schedule] <Insert manufacturer's name and trade name>.
4. Backward-Inclined Airfoil Blades:
 - a. Aerodynamic design.
 - b. Heavy backplate.
 - c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
5. Backward-Inclined Curved Blades:
 - a. Curved design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded at tip flange and backplate.
6. Backward-Inclined Flat Blades:
 - a. Flat design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded at tip flange and backplate.
7. Forward-Curved Blades:
 - a. Curved design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded or riveted at tip flange and backplate.

D. Shafts:

1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

E. Bearings:

1. Heavy-duty regreasable ball or roller type in a cast iron pillowblock housing.
2. Ball-Bearing Rating Life: ABMA 9, L(10) of 80,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L(10) of 80,000 hours.
4. Extend grease fitting to accessible location outside of unit.

Retain below only if belt driven motors are used.

F. Belt Drive:

1. Factory mounted, with final alignment and belt adjustment made after installation.
2. Service Factor Based on Fan Motor Size: 1.2.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards," [0.146 inch-] <Insert dimension> thick, [3/4-inch] <Insert dimension> diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

- G. Motor Enclosure: [Open, dripproof] [Totally enclosed, fan cooled] [Explosion-proof] <Insert motor enclosure type>.

Retain option below for EC Motor option. Note these are limited in size of motor and voltages (typically 120V on motors up to 3/4 HP). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

H. EC (Electrically Commutated) Motor:

1. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be a minimum of 85% efficient at all speeds.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]

- 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
- 3) [A 0-10 VDC external signal.]
- 4) [Factory provided remote speed controller.]
- 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

Retain option below for PM Motor option. Note these are limited in size of motor and voltages (less than 30 HP but available in multiple voltages). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

I. PM (Permanent Magnet) Motor:

1. Units to utilize a variable torque Permanent Magnet (PM) motor with separate motor controller. Controller is factory installed, wired and programmed for the maximum rpm based on the actual fan selection.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

J. Accessories:

Select from the accessories below. Items 1-5 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Inlet and Outlet: Flanged.
3. Access Door: Gasketed door in scroll with latch-type handles.
4. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
5. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
6. Companion Flanges: Rolled flanges for duct connections of same material as housing.
7. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades, with felt edges in steel frame installed on fan discharge.
8. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
9. Inlet Screens: Removable wire mesh.
10. Outlet Screens: Removable wire mesh.
11. Belt Guard: OSHA-compliant, completely enclosed shaft and drive components.

12. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
13. Discharge Dampers: Assembly with [parallel] [opposed] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
14. Grease Collection Trough and Receiver: For restaurant exhaust application.
15. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2.9 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.10 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Compliance: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311 and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify fans according to AMCA 99.

PART 3 - EXECUTION

3.1 INSTALLATION OF CENTRIFUGAL HVAC FANS

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:

1. Install floor- or roof-mounted centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in 230501 "Basic Materials and Methods for HVAC".
2. Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

Select from the two paragraphs below. First paragraph is for projects with Seismic requirements.

3. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- E. Curb Support, Field Built-Up: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," detail "Equipment Support Curb," number "SPF-9" (page 1409) and detail "Equipment Support Curb," number "SPF-9S" (page 1410). Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
- F. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.
- G. Unit Support: Install centrifugal fans level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.

Select from the options below if seismic restraints are required.

- H. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation[**and seismic-control**] devices.
1. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.
 2. Comply with requirements in [**Section 230548 "Vibration and Seismic Controls for HVAC"**] [**Section 230548.13 "Vibration Controls for HVAC"**] for vibration-isolation[**and seismic-control**] devices.
- I. Install units with clearances for service and maintenance.
- J. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- K. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.2 DUCTWORK AND PIPING CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.

- C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.
- D. Install heat tracing on all drain piping subject to freezing temperature and as indicated on Drawings. Furnish and install heat tracing according to Section 230553 "Heat Tracing for HVAC Piping."

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that there is adequate maintenance and access space.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 6. Adjust belt tension.
 - 7. Adjust damper linkages for proper damper operation.
 - 8. Verify lubrication for bearings and other moving parts.
 - 9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 10. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416

KSU DESIGNERS NOTES:

1. Preferred Manufacturers: Loren Cook – Preferred, Greenheck, Twin City, Lab exhaust - Twin City, Strobic, Loren Cook - All equivalents as approved by OUA
2. Motor sizes to be selected for NON-OVERLOADING condition so as to prevent nuisance trips.
3. Direct drive assemblies are preferred over belt driven motors to minimize maintenance and belt losses.
4. Exhaust fans with 3 phase motors may be belt driven. Belt driven fans shall incorporate cogged v-belts or synchronous drive belts on 10 MHP and above to reduce drive losses when installed without a VFD.
5. Green technology toilet exhaust fans with direct drive, electrically commutated motors and speed control shall be considered to minimize campus maintenance requirements.
6. All exhaust fans shall have means of disconnecting power to drive unit externally located at or close to the unit.
7. Control toilet room exhaust system with occupancy sensor controls and/or through the BAS when applicable. Review with KSU OUA.
8. Roof mounted fans with dampers, gravity or motorized, shall be installed with access to the damper via a hinged mounting or with access doors.
9. Review all exhaust fan application with the use of energy recovery coils and systems.
10. Kitchen exhausts fans and curbs to be reviewed with OUA.

11. Lab Exhaust Fans: Strobic or Twin City vertical discharge fan with louvered curb housing if budget allows. Associate to review coating requirements for lab application. All lab exhaust systems to discharge minimum 7'-0" above roof line or per applicable code.
12. See links below to typical coatings available for Greenheck and Cook. These go in great detail of chemical resistance of each of coating to various chemicals.
http://www.lorencook.com/PDFs/Catalogs/Coatings_Brochure.pdf
http://www.adehvac.com/uploads/application/files/greenheck_coating_application.pdf
13. Per ASHRAE 90.1-2010 all outdoor air and exhaust air systems shall be equipped with motorized dampers that will automatically shut when the systems are not in use. Backdraft dampers are only acceptable in systems with an outdoor air intake or exhaust capacity of 300 cfm or less.
14. Spark-Resistant Construction: AMCA 99 defines three types of construction, including the following:
 - a. Type A: All parts of the fan in contact with the airstream are constructed of nonferrous material.
 - b. Type B: The fan has a nonferrous wheel and ring around the opening through which the shaft passes.
 - c. Type C: The fan has a nonferrous inlet cone and housing cover plate to prevent ferrous parts from striking each other.

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

Retain only fans applicable to project here and in from Part 2 as well.

- A. Section Includes:

1. Axial roof ventilators.
2. Ceiling-mounted ventilators.
3. Centrifugal ventilators - roof downblast.
4. Centrifugal ventilators - roof upblast and sidewall.
5. Sidewall propeller fans.
6. Upblast propeller roof exhaust fans.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

- B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints.

5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

- G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- H. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

Retain paragraph below only if belt driven fans are specified.

1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual project site elevations.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- B. Seismic Performance: HVAC power ventilators shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7].
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [and the unit will be fully operational after the seismic event]."
 2. Component Importance Factor: [1.5] [1.0].

- C. Capacities and Characteristics: See Schedules on Drawings.
- D. Manufacturers: Subject to compliance with requirements, provide fan products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. Twin City Fans.
- E. Source Limitations: Obtain fans from single manufacturer.

2.2 AXIAL ROOF VENTILATORS

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select wheel assemblies to suit project and systems conveyed by fans.

- A. Description: Fan wheel and housing, factory-mounted motor with [belt] [or] [direct] drive and accessories.
- B. Housing: Heavy-gauge, removable, spun-aluminum dome top; square, one-piece, hinged, aluminum base.
- C. Fan Wheel: [Aluminum] [Steel] hub and blades. [Sparkproof construction.]

Retain below only if belt driven motors are used.

- D. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.

Select from the accessories below. Items 1-3 are typical. Remaining options are project specific. Review with manufacturer.

- E. Accessories:
 - 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 3. Extended lubrication lines.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
 - 6. Stack hood with built-in backdraft dampers.

- F. Prefabricated Roof Curbs: Heavy gage, aluminum, mitered and welded corners; 1-1/2 in. thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2 inch wood nailer. Size as required to suit roof opening and fan base.

Select from options listed below.

1. Overall Height: [12 inches] [16 inches].
2. Vibration Isolation: 1.0" deflection perimeter vibration isolation curb. See Specification Section 230548.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufactured curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: [1/2-inch-] [5/8-inch-] [3/4-inch-] thick steel bars welded in place to form 6-inch squares.
7. Mounting Pedestal: Galvanized steel with removable access panel.

2.3 CEILING-MOUNTED VENTILATORS

- A. Housing: Steel, lined with acoustical insulation.
- B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.
- C. Back-draft damper: Integral.
- D. Grille: [Plastic] [Stainless steel] [Aluminum] [Painted aluminum], louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

Retain option below for EC Motor option. Note these are limited in size of motor and voltages (typically 120V on motors up to 3/4 HP). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

F. EC (Electrically Commutated) Motor:

1. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be a minimum of 85% efficient at all speeds.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]

- 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
- 3) [A 0-10 VDC external signal.]
- 4) [Factory provided remote speed controller.]
- 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

G. Accessories:

Select from the accessories below. Options are project specific. Review with manufacturer.

1. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
3. Motion Sensor: Motion detector with adjustable shutoff timer.
4. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
5. Filter: Washable aluminum to fit between fan and grille.
6. Isolation: Rubber-in-shear vibration isolators.
7. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.4 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select housing construction and wheel assemblies to suit project and systems conveyed by fans.

- A. Description: Fan wheel and housing, factory-mounted motor with [belt] [or] [direct] drive and accessories.
- B. Housing: Downblast; removable spun-aluminum dome; square, one-piece aluminum base with venturi inlet cone.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades[; sparkproof construction].

Retain below only if belt driven motors are used.

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
6. Fan and motor isolated from exhaust airstream.

Retain option below for EC Motor option. Note these are limited in size of motor and voltages (typically 120V on motors up to 3/4 HP). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

E. EC (Electrically Commutated) Motor:

1. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be a minimum of 85% efficient at all speeds.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

Retain option below for PM Motor option. Note these are limited in size of motor and voltages (less than 30 HP but available in multiple voltages). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

F. PM (Permanent Magnet) Motor:

1. Units to utilize a variable torque Permanent Magnet (PM) motor with separate motor controller. Controller is factory installed, wired and programmed for the maximum rpm based on the actual fan selection.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

G. Accessories:

Select from the accessories below. Items 1-2 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
 5. Spark-resistant, all-aluminum wheel construction.
 6. Mounting Pedestal: Galvanized steel with removable access panel.
- H. Prefabricated Roof Curbs: Heavy gage, aluminum, mitered and welded corners; 1-1/2 in. thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2 inch wood nailer. Size as required to suit roof opening and fan base.

Select from options listed below.

1. Overall Height: [12 inches] [16 inches].
2. Vibration Isolation: 1.0" deflection perimeter vibration isolation curb. See Specification Section 230548.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufactured curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: [1/2-inch-] [5/8-inch-] [3/4-inch-] thick steel bars welded in place to form 6-inch squares.
7. Mounting Pedestal: Galvanized steel with removable access panel.

2.5 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

Edit below to suit application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select housing construction and wheel assemblies to suit project and systems conveyed by fans.

- A. Description: Fan wheel and housing, factory-mounted motor with [belt] [or] [direct] drive and accessories.
- B. Configuration: Centrifugal [roof upblast] [roof upblast, grease hood kitchen] [sidewall] ventilator.
- C. Housing: Removable spun-aluminum dome top; square, one-piece aluminum base with venturi inlet cone.
 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
 2. [Provide grease collector.]
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades[; sparkproof construction].

Retain below only if belt driven motors are used.

E. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
6. Fan and motor isolated from exhaust airstream.

Retain option below for EC Motor option. Note these are limited in size of motor and voltages (typically 120V on motors up to 3/4 HP). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

F. EC (Electrically Commutated) Motor:

1. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be a minimum of 85% efficient at all speeds.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

Retain option below for PM Motor option. Note these are limited in size of motor and voltages (less than 30 HP but available in multiple voltages). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

G. PM (Permanent Magnet) Motor:

1. Units to utilize a variable torque Permanent Magnet (PM) motor with separate motor controller. Controller is factory installed, wired and programmed for the maximum rpm based on the actual fan selection.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

H. Accessories:

Select from the accessories below. Items 1-2 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
5. Spark-resistant, all-aluminum wheel construction.
6. Mounting Pedestal: Galvanized steel with removable access panel.
7. Wall Mount Adapter: Attach wall-mounted fan to wall.
8. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.

- I. Prefabricated Roof Curbs: Heavy gage, aluminum, mitered and welded corners; 1-1/2 in. thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2 inch wood nailer. Size as required to suit roof opening and fan base.

Select from options listed below.

1. Overall Height: [12 inches] [16 inches].
2. Vibration Isolation: 1.0" deflection perimeter vibration isolation curb. See Specification Section 230548.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufactured curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: [1/2-inch-] [5/8-inch-] [3/4-inch-] thick steel bars welded in place to form 6-inch squares.
7. Mounting Pedestal: Galvanized steel with removable access panel.

- J. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.

Select from options listed below.

1. Vented Curb: For kitchen exhaust; 12-inch-high galvanized steel; unlined, with louvered vents in vertical sides.
2. NFPA 96 code requirements for commercial cooking operations.
3. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.
4. Configuration: Built-in raised cant and mounting flange.
5. Overall Height: [12 inches] [16 inches].
6. Hinged sub-base to provide access to damper or as cleanout for grease applications.
7. Burglar Bars: [1/2-inch-] [5/8-inch-] [3/4-inch-] thick steel bars welded in place to form 6-inch squares.
8. Pitch Mounting: Manufactured curb for roof slope.
9. Mounting Pedestal: Galvanized steel with removable access panel.

2.6 SIDEWALL PROPELLER FANS

Edit below to suite application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select housing construction and wheel assemblies to suit project and systems conveyed by fans.

- A. Description: Fan wheel and housing, factory-mounted motor with [belt] [or] [direct] drive and accessories.
- B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.

Select from the two options below. Aluminum blades are normally used in large sizes and in high-static-pressure applications.

- C. Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.
- D. Fan Wheel: Replaceable, [cast] [extruded]-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

Select of the two options below for direct or belt driven motors.

- E. Fan Drive: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- F. Fan Drive:
 1. Belt drive.
 2. Resiliently mounted to housing.
 3. Statically and dynamically balanced.
 4. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 5. Extend grease fitting to accessible location outside of unit.
 6. Service Factor Based on Fan Motor Size: 1.4.
 7. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 8. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

- a. Ball-Bearing Rating Life: ABMA 9, L(10) of 100,000 hours.
- 9. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
- 10. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
- 11. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
- 12. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

Retain option below for EC Motor option. Note these are limited in size of motor and voltages (typically 120V on motors up to 3/4 HP). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

G. EC (Electrically Commutated) Motor:

- 1. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be a minimum of 85% efficient at all speeds.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]
 - 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
 - 3) [A 0-10 VDC external signal.]
 - 4) [Factory provided remote speed controller.]
 - 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

Retain option below for PM Motor option. Note these are limited in size of motor and voltages (less than 30 HP but available in multiple voltages). Also, only available on direct drive installations. Select whether speed control will be by a potentiometer dial, 0-10-VDC signal, or other means as indicated below. Review availability with manufacturer as this technology is expanding.

H. PM (Permanent Magnet) Motor:

- 1. Units to utilize a variable torque Permanent Magnet (PM) motor with separate motor controller. Controller is factory installed, wired and programmed for the maximum rpm based on the actual fan selection.
 - a. Speed shall be controlled by:
 - 1) [A factory mounted potentiometer dial mounted on the motor.]

- 2) [Factory provided pressure controller with a 0-10 VDC output signal to motor to maintain a constant static or differential pressure at a given set point in a duct, a space, or between areas.]
- 3) [A 0-10 VDC external signal.]
- 4) [Factory provided remote speed controller.]
- 5) [Factory provided wall mounted universal [temperature] [humidity] [carbon dioxide] [VOC] controller with 0-10VDC output signal. Controller to have dry contacts for monitoring and BACnet or be Modbus network compatible.]

I. Accessories:

Select from the accessories below. Items 1-2 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
5. Wall Sleeve: Galvanized steel to match fan and accessory size.
6. Weathershield Hood: Galvanized steel to match fan and accessory size.
7. Weathershield Front Guard: Galvanized steel with expanded metal screen.

2.7 UPBLAST PROPELLER ROOF EXHAUST FANS

Edit below to suite application. Direct driven motors are preferred where possible to limit maintenance and eliminate belt losses. Select wheel assemblies to suit project and systems conveyed by fans.

- A. Configuration: Upblast propeller [grease hood kitchen] ventilator.
- B. Wind Band, Fan Housing, and Base: Reinforced and braced [galvanized steel] [aluminum], containing rain trough, motor and drive assembly, and fan wheel.
 1. Damper Rods: Steel with [bronze] [nylon] bearings.
 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
 3. [Provide grease collector.]
- C. Fan Wheel: Replaceable, [cast] [extruded]-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades[; sparkproof construction].

Retain below only if belt driven motors are used.

D. Belt Drives:

1. Resiliently mounted to housing.
2. Weatherproof housing of same material as fan housing.

3. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
4. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
5. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
6. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
7. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.

E. Accessories:

Select from the accessories below. Items 1-2 are typical. Remaining options are project specific. Review with manufacturer.

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Inspection Door: Hinged.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Extended Lubrication Lines.
7. Kitchen Hood Exhaust: UL 762 listed for grease-laden air exhaust.

- F. Prefabricated Roof Curbs: Heavy gage, aluminum, mitered and welded corners; 1-1/2 in. thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2 inch wood nailer. Size as required to suit roof opening and fan base.

Select from options listed below.

1. Overall Height: [12 inches] [16 inches].
2. Vibration Isolation: 1.0" deflection perimeter vibration isolation curb. See Specification Section 230548.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufactured curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: [1/2-inch-] [5/8-inch-] [3/4-inch-] thick steel bars welded in place to form 6-inch squares.
7. Mounting Pedestal: Galvanized steel with removable access panel.

- G. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.

Select from options listed below.

1. Vented Curb: For kitchen exhaust; 12-inch-high galvanized steel; unlined, with louvered vents in vertical sides.
2. NFPA 96 code requirements for commercial cooking operations.
3. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.
4. Configuration: Built-in raised cant and mounting flange.
5. Overall Height: [12 inches] [16 inches].

6. Hinged sub-base to provide access to damper or as cleanout for grease applications.
7. Burglar Bars: [1/2-inch-] [5/8-inch-] [3/4-inch-] thick steel bars welded in place to form 6-inch squares.
8. Pitch Mounting: Manufactured curb for roof slope.
9. Mounting Pedestal: Galvanized steel with removable access panel.

2.8 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.9 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify according to AMCA 99.
- F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

- A. Install power ventilators level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

Select from the two paragraphs below. First paragraph is for projects with Seismic requirements.

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

- E. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
- F. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- G. Support suspended units from structure using threaded steel rods. Vibration-control devices are specified in Section 230548.
- H. Install units with clearances for service and maintenance.
- I. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- J. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that there is adequate maintenance and access space.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 6. Adjust belt tension.
 - 7. Adjust damper linkages for proper damper operation.
 - 8. Verify lubrication for bearings and other moving parts.
 - 9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 11. Shut unit down and reconnect automatic temperature-control operators.
 - 12. Remove and replace malfunctioning units and retest as specified above.
- F. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.

- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423

KSU DESIGNERS NOTES:

1. Preferred Manufacturers: Loren Cook – Preferred, Greenheck, Twin City, Lab exhaust - Twin City, Strobic, Loren Cook - All equivalents as approved by OUA
2. Motor sizes to be selected for NON-OVERLOADING condition so as to prevent nuisance trips.
3. Direct drive assemblies are preferred over belt driven motors to minimize maintenance and belt losses.
4. Exhaust fans with 3 phase motors may be belt driven. Belt driven fans shall incorporate cogged v-belts or synchronous drive belts on 10 MHP and above to reduce drive losses when installed without a VFD.
5. Green technology toilet exhaust fans with direct drive, electrically commutated motors and speed control shall be considered to minimize campus maintenance requirements.
6. All exhaust fans shall have means of disconnecting power to drive unit externally located at or close to the unit.
7. Control toilet room exhaust system with occupancy sensor controls and/or through the BAS when applicable. Review with KSU OUA.
8. Roof mounted fans with dampers, gravity or motorized, shall be installed with access to the damper via a hinged mounting or with access doors.
9. Review all exhaust fan application with the use of energy recovery coils and systems.
10. Kitchen exhausts fans and curbs to be reviewed with OUA.
11. Lab Exhaust Fans: Strobic or Twin City vertical discharge fan with louvered curb housing if budget allows. Associate to review coating requirements for lab

application. All lab exhaust systems to discharge minimum 7'-0" above roof line or per applicable code.

12. See links below to typical coatings available for Greenheck and Cook. These go in great detail of chemical resistance of each of coating to various chemicals.

[http://www.lorencook.com/PDFs/Catalogs/Coatings Brochure.pdf](http://www.lorencook.com/PDFs/Catalogs/Coatings%20Brochure.pdf)

[http://www.adehvac.com/uploads/application/files/greenheck coating application.pdf](http://www.adehvac.com/uploads/application/files/greenheck%20coating%20application.pdf)

13. Per ASHRAE 90.1-2010 all outdoor air and exhaust air systems shall be equipped with motorized dampers that will automatically shut when the systems are not in use. Backdraft dampers are only acceptable in systems with an outdoor air intake or exhaust capacity of 300 cfm or less.

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Extent of air terminals work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Section Includes:

Retain only fans applicable to project here and in from Part 2 as well.

- 1. Shutoff, single-duct air terminal units.
- 2. Parallel, fan-powered air terminal units.
- 3. Series, fan-powered air terminal units.
- 4. Dual-duct air terminal units.
- 5. Diffuser-type air terminal units.
- 6. Underfloor air distribution terminal units.
- 7. Underfloor air distribution floor induction units.
- 8. Exhaust single-duct terminal units.
- 9. Casing liner.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For air terminal units.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

4. Hangers and supports, including methods for duct and building attachment **[, seismic restraints,]** and vibration isolation.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air terminals with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Codes and Standards:
 1. ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards, and bear ADC Seal.
- C. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".

1.5 INFORMATIONAL SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Ceiling suspension assembly members.
 2. Size and location of initial access modules for acoustic tile.
 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Instructions for resetting minimum and maximum air volumes.

- b. Instructions for adjusting software set points.

Retain below ONLY if fan powered terminal units are applicable to the project.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver air terminals wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of air terminal and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in boxes.
- B. Store air terminals in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ENVIRO-TEC; by Johnson Controls, Inc.
 2. Johnson Controls (Sizes 8" and under only).
 3. Krueger.
 4. Price Industries.
 5. Titus.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 22 gage (0.034-inch thick) galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric (closed cell foam – fiber free) duct liner.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

Include sound attenuators where required.

E. Attenuator Section: 22 gage (0.034-inch thick) steel sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric (closed cell foam – fiber free) duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Select from heating coil type below as applicable to project.

F. Hydronic Heating Coils: Coils to be connected to terminal unit and enclosed in a minimum 22 gauge galvanized steel casing with slip and drive construction for attachment to metal ductwork. Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to tubes. Tubes shall be copper with minimum wall thickness of .016" with male solder header connections. Provide with integral screwed access door upstream of heating coil. Number of coil rows and circuits shall be selected to provide performance as required per the plans. Coil performance data shall be based on tests run in accordance with ARI Standard 410.

G. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

Select from the first two options below. Preference is for SCR control in lieu of staged control. Be careful in selecting electric coil sizes as they are limited in kW, voltages, and are not as forgiving as hydronic coils. Mercury contactor option has been deleted due to environmental concerns.

1. Silicon Controlled Rectifier (SCR) controlled.
2. Stage(s): **1** **2** **3**.
3. Magnetic contactor for each step of control (for three-phase coils).
4. Access door interlocked **fused** **non-fused** disconnect switch.
5. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
6. Nickel chrome 80/20 heating elements.
7. Airflow switch for proof of airflow.
8. Fan interlock contacts.

9. Fuses in terminal box for overcurrent protection (for coils more than 48 A).

Select this option and edit accordingly for terminal units to be provided with actuators, controllers, and thermostats to be by the terminal unit manufacturer. Edit out thermostat if it is to be provided by the TCC.

- H. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

1. Electronic Damper Actuator: 24 V, powered open.
2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
3. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
4. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Occupied and unoccupied operating mode.
 - b. Remote reset of airflow or temperature set points.
 - c. Adjusting and monitoring with portable terminal.
 - d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Retain below when actuators, controllers, and thermostats are to be by the TCC.

- I. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Actuators shall be capable of supplying at least 35 in-lb of torque to the diameter shaft and shall be mounted externally for service access.

Select from the options below. KSU preference is for the actuator and controllers to be installed at the factory in lieu of the field. May not be an option in all instances depending on the project schedule.

1. Actuator and controller to be furnished by the temperature controls contractor to the manufacturer for factory mounting by terminal unit manufacturer.
2. Actuator and controller to be furnished and installed by the temperature controls contractor in the field.

2.3 PARALLEL FAN-POWERED AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ENVIRO-TEC; by Johnson Controls, Inc.
 2. Johnson Controls.
 3. Krueger.
 4. Price Industries.
 5. Titus.

- B. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud.
- C. Casing: 22 gage (0.034-inch) thick galvanized steel, single wall.
 - 1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric (closed cell foam – fiber free) duct liner.
 - 2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Fan: Forward-curved centrifugal, located at plenum air inlet.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- E. Velocity Sensors: Multipoint array with velocity sensors.
- F. Motor:
 - 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Select from the options below. Preference is for EC motors where possible.

- 2. Type: [Permanent-split capacitor with SCR for speed adjustment] [Electronically commutated motor].
- 3. Fan-Motor Assembly Isolation: Rubber isolators.
- 4. Enclosure: [Open dripproof] [Totally enclosed, fan cooled] [Totally enclosed, air over] [Open, externally ventilated] [Totally enclosed, nonventilated] [Severe duty] [Explosion proof] [Dust-ignition-proof machine].
- 5. Efficiency: Premium efficient.
- 6. NEMA Design: <Insert designation>.
- 7. Service Factor: 1.15.
- 8. Motor Speed: [Single speed] [Multispeed].
 - a. Speed Control: Infinitely adjustable with electronic controls.
- 9. Electrical Characteristics – See Schedules on Drawings.

Note 1” filter is standard offering.

- G. Filters:
 - 1. Minimum Efficiency Reporting Value: According to ASHRAE 52.2.
 - 2. Material: Pleated cotton-polyester media, MERV 7.
 - 3. Thickness: [2 inches] [1 inch].

Include sound attenuators where required.

- H. Attenuator Section: 22 gage (0.034-inch thick) galvanized steel sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric (closed cell foam – fiber free) duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Select from heating coil type below as applicable to project.

- I. Hydronic Heating Coils: Coils to be connected to terminal unit and enclosed in a minimum 22 gauge galvanized steel casing with slip and drive construction for attachment to metal ductwork. Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to tubes. Tubes shall be copper with minimum wall thickness of .016" with male solder header connections. Provide with integral screwed access door upstream of heating coil. Number of coil rows and circuits shall be selected to provide performance as required per the plans. Coil performance data shall be based on tests run in accordance with ARI Standard 410.
 1. Location: Plenum air inlet or in reheat position as indicated on the drawings.
- J. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
 1. Location: Plenum air inlet or in reheat position as indicated on the drawings.

Select from the two options below. Preference is for SCR control in lieu of staged control. Be careful in selecting electric coil sizes as they are limited in kW, voltages, and are not as forgiving as hydronic coils. Mercury contactor option has been deleted due to environmental concerns.

2. Silicon Controlled Rectifier (SCR) controlled.
3. Stage(s): **[1] [2] [3]**.
4. Magnetic contactor for each step of control (for three-phase coils).
5. Access door interlocked **[fused] [non-fused]** disconnect switch.
6. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
7. Nickel chrome 80/20 heating elements.
8. Airflow switch for proof of airflow.
9. Fan interlock contacts.
10. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
- K. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
 1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
 2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
 3. Disconnect Switch: Factory-mounted, non-fused toggle type for units without electric heat.

4. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

Select this option and edit accordingly for terminal units to be provided with actuators, controllers, and thermostats to be by the terminal unit manufacturer. Edit out thermostat if it is to be provided by the TCC.

- L. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 1. Electronic Damper Actuator: 24 V, powered open, fail to last indicated position.
 2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
 3. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
 4. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

Retain below when actuators, controllers, and thermostats are to be by the TCC.

- M. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Actuators shall be capable of supplying at least 35 in-lb of torque to the diameter shaft and shall be mounted externally for service access.

Select from the options below. KSU preference is for the actuator and controllers to be installed at the factory in lieu of the field. May not be an option in all instances depending on the project schedule.

1. Actuator and controller to be furnished by the temperature controls contractor to the manufacturer for factory mounting by terminal unit manufacturer.
2. Actuator and controller to be furnished and installed by the temperature controls contractor in the field.

2.4 SERIES FAN-POWERED AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ENVIRO-TEC; by Johnson Controls, Inc.
 2. Johnson Controls.
 3. Krueger.
 4. Price Industries.
 5. Titus.
- B. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud for installation above a ceiling.
 1. Designed for quiet operation.

- C. Casing: 22 gage (0.034-inch thick) galvanized steel, single wall.
1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric (closed cell foam – fiber free) duct liner.
 2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
 3. Air Outlet: S-slip and drive connections.
 4. Fan: Forward-curved centrifugal.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- E. Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.
- F. Motor:
1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Select from the options below. Preference is for EC motors where possible.

2. Type: [Permanent-split capacitor with SCR for speed adjustment] [Electronically commutated motor].
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: [Open dripproof] [Totally enclosed, fan cooled] [Totally enclosed, air over] [Open, externally ventilated] [Totally enclosed, nonventilated] [Severe duty] [Explosion proof] [Dust-ignition-proof machine].
5. Efficiency: Premium efficient.
6. NEMA Design: <Insert designation>.
7. Service Factor: 1.15.
8. Motor Speed: [Single speed] [Multispeed].
 - a. Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.
9. Electrical Characteristics: See Schedules on Drawings.

Note 1" filter is standard offering.

- G. Filters:
1. Minimum Efficiency Reporting Value: According to ASHRAE 52.2.
 2. Material: Pleated cotton-polyester media **MERV 7**.
 3. Thickness: [2 inches] [1 inch].

Include sound attenuators where required.

- H. Attenuator Section: 22 gage (0.034-inch galvanized steel) sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric (closed cell foam – fiber free) duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1

Select from heating coil type below as applicable to project.

- I. Hydronic Heating Coils: Coils to be connected to terminal unit and enclosed in a minimum 22 gauge galvanized steel casing with slip and drive construction for attachment to metal ductwork. Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to tubes. Tubes shall be copper with minimum wall thickness of .016" with male solder header connections. Provide with integral screwed access door upstream of heating coil. Number of coil rows and circuits shall be selected to provide performance as required per the plans. Coil performance data shall be based on tests run in accordance with ARI Standard 410.
- J. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

Select from the first two options below. Preference is for SCR control in lieu of staged control. Be careful in selecting electric coil sizes as they are limited in kW, voltages, and are not as forgiving as hydronic coils. Mercury contactor option has been deleted due to environmental concerns.

1. Silicon Controlled Rectifier (SCR) controlled.
 2. Stage(s): **[1] [2] [3]**.
 3. Magnetic contactor for each step of control (for three-phase coils).
 4. Access door interlocked **[fused] [non-fused]** disconnect switch.
 5. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 6. Nickel chrome 80/20 heating elements.
 7. Airflow switch for proof of airflow.
 8. Fan interlock contacts.
 9. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
- K. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
 1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
 2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
 3. Disconnect Switch: Factory-mounted, non-fused toggle type for units without electric heat.
 - L. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

Select this option and edit accordingly for terminal units to be provided with actuators, controllers, and thermostats to be by the terminal unit manufacturer. Edit out thermostat if it is to be provided by the TCC.

- M. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
1. Electronic Damper Actuator: 24 V, powered open, fail to last indicated position.
 2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
 3. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
 4. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Occupied and unoccupied operating mode.
 - b. Remote reset of airflow or temperature set points.
 - c. Adjusting and monitoring with portable terminal.
 - d. Communication with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC."

Retain below when actuators, controllers, and thermostats are to be by the TCC.

- N. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Actuators shall be capable of supplying at least 35 in-lb of torque to the diameter shaft and shall be mounted externally for service access.

Select from the options below. KSU preference is for the actuator and controllers to be installed at the factory in lieu of the field. May not be an option in all instances depending on the project schedule.

1. Actuator and controller to be furnished by the temperature controls contractor to the manufacturer for factory mounting by terminal unit manufacturer.
2. Actuator and controller to be furnished and installed by the temperature controls contractor in the field.

2.5 DUAL-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ENVIRO-TEC; by Johnson Controls, Inc.
 2. Johnson Controls.
 3. Krueger.
 4. Price Industries.
 5. Titus.

- B. Configuration: Mixing with two volume dampers inside unit casing with mixing attenuator section and control components inside a protective metal shroud.
- C. Casing: 22 gage (0.034-inch thick) galvanized steel, single wall.
1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric (closed cell foam – fiber free) duct liner.
 2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
 3. Air Outlet: S-slip and drive connections.
 4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

Select location of velocity sensors. Can be either or a combination of the options below with one in the cold deck and at the air outlet.

- E. Velocity Sensors: Multipoint array with velocity sensors in **air inlets** **and** **air outlets**.

Include sound attenuators where required.

- F. Attenuator Section: 0.034-inch galvanized steel sheet.
1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric (closed cell foam – fiber free) duct liner.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Select this option and edit accordingly for terminal units to be provided with actuators, controllers, and thermostats to be by the terminal unit manufacturer. Edit out thermostat if it is to be provided by the TCC.

- G. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
1. Electronic Damper Actuator: 24 V, powered open, fail to last indicated position.
 2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
 3. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
 4. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

Retain below when actuators, controllers, and thermostats are to be by the TCC.

- H. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Actuators shall be capable

of supplying at least 35 in-lb of torque to the diameter shaft and shall be mounted externally for service access.

Select from the options below. KSU preference is for the actuator and controllers to be installed at the factory in lieu of the field. May not be an option in all instances depending on the project schedule.

1. Actuator and controller to be furnished by the temperature controls contractor to the manufacturer for factory mounting by terminal unit manufacturer.
2. Actuator and controller to be furnished and installed by the temperature controls contractor in the field.

2.6 DIFFUSER-TYPE AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acutherm or approved equal.

Edit below as applicable to design. Standard offerings are standalone diffuser with integral thermostat or wall mounted thermostat with / without BACnet MSTP interface.

- B. Configuration: Volume-damper, diffuser, controller assembly and [standalone integral thermostat / sensing element] [wall-mounted thermostat] [with master-slave capability].
- C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
- D. Diffuser: Galvanized steel with white baked-enamel finish.
- E. Control Sequence: Diffusion dampers open and close to regulate airflow into the room in response to room temperature. [The dampers are mechanically actuated by internal, factory-set thermal element thermostats with limited field adjustment.] [The dampers are mechanically actuated by an electric motor and controller through a wall mounted thermostat] [with BACnet MSTP DDC building control network interface.]

2.7 UNDERFLOOR AIR DISTRIBUTION TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ENVIRO-TEC; by Johnson Controls, Inc.
2. Johnson Controls.
3. Price Industries.
4. Titus.

Edit options below that are relevant to project.

- B. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud within a raised access floor. Designed for [pressurized floor cavity supply] [and] [ducted air supply].

- C. Casing: 22 gage (0.034-inch) thick galvanized steel, single wall.
1. Integral floor discharge diffusers.
 2. Mixing damper.
 3. VAV throttling damper.
 4. Leveling feet.
 5. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric (closed cell foam – fiber free) duct liner.
 6. Air Outlet: S-slip and drive connections.
 7. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
 8. Fan: Forward-curved centrifugal **in double blower configuration** **with double blowers as indicated**.
 9. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- E. Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.
- F. Motor:
1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- Select from the options and controller type below. Preference is for EC motors where possible.**
2. Type: **Permanent-split capacitor with SCR for speed adjustment** **Electronically commutated motor**.
 3. Fan-Motor Assembly Isolation: Rubber isolators.
 4. Enclosure: **Open dripproof** **Totally enclosed, fan cooled** **Totally enclosed, air over** **Open, externally ventilated** **Totally enclosed, nonventilated** **Severe duty** **Explosion proof** **Dust-ignition-proof machine**.
 5. Efficiency: Premium efficient.
 6. NEMA Design: **<Insert designation>**.
 7. Service Factor: 1.15.
 8. Motor Speed: **Single speed** **Multispeed**.
 9. Electrical Characteristics: See Schedule on Drawings.
- G. Controller Type: **Plenum Pressure Controllers** **Individual Diffuser Controller** **Terminal Unit Controller**.
- H. Accessories:
1. Inlet filter.
 2. Disconnect switch.
 3. Transformers.
 4. Airflow switch.

2.8 UNDERFLOOR AIR DISTRIBUTION FLOOR INDUCTION UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation; a unit of United Technologies Corp.
 2. Nailor Industries Inc.
 3. Price Industries.
 4. Trox USA Inc.

Edit below when hydronic coils are included.

- B. Configuration: Raised-access floor-mounting units with ducted primary air **and hydronic coil(s)**. Air is discharged to space through nozzles. Design includes secondary air induced from served space.
- C. Casing: 22 gage (0.034-inch) thick galvanized steel, single wall. Casing includes removable aluminum linear grille and plenum with interior painted black.
1. Provide air mixing chamber.
 2. Provide casing space for control valves and actuators.
 3. Casing to have adjustable feet.
- D. Hydronic Heating Coils: As indicated on Drawings. Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F.
1. Coils to be painted black.

2.9 EXHAUST SINGLE-DUCT TERMINAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ENVIRO-TEC; by Johnson Controls, Inc.
 2. Johnson Controls.
 3. Krueger.
 4. Price Industries.
 5. Titus.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 22 gage (0.034-inch thick) galvanized steel, single wall. Casing includes removable aluminum linear grille and plenum.
1. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 2. Air Outlet: S-slip and drive connections.
 3. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

Include sound attenuators where required.

E. Attenuator Section: 22 gage (0.034-inch thick) galvanized steel sheet.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.

Select this option and edit accordingly for terminal units to be provided with actuators, controllers, and thermostats to be by the terminal unit manufacturer. Edit out thermostat if it is to be provided by the TCC.

A. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

1. Electronic Damper Actuator: 24 V, powered open, fail to last indicated position.
2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
3. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
4. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

Retain below when actuators, controllers, and thermostats are to be by the TCC.

B. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Actuators shall be capable of supplying at least 35 in-lb of torque to the diameter shaft and shall be mounted externally for service access.

Select from the options below. KSU preference is for the actuator and controllers to be installed at the factory in lieu of the field. May not be an option in all instances depending on the project schedule.

1. Actuator and controller to be furnished by the temperature controls contractor to the manufacturer for factory mounting by terminal unit manufacturer.
2. Actuator and controller to be furnished and installed by the temperature controls contractor in the field.

2.10 CASING LINER

A. Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Minimum Thickness: 1/2 inch.

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.11 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to AHRI 880.
 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

1. Comply with [SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."] [ASCE/SEI 7.] Comply with requirements for seismic-restraint devices in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

- B. **Install seismic-restraint devices using methods approved by [an evaluation service member of the ICC Evaluation Service] [the Office of Statewide Health Planning and Development for the State of California] [an agency acceptable to authorities having jurisdiction].**
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on air terminal units that are suspended with vibration isolators.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- F. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.3 TERMINAL UNIT INSTALLATION

- A. Install air terminals as indicated, and in accordance with manufacturer's installation instructions.
- B. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- C. Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.
- D. Install wall-mounted thermostats.

3.4 CONNECTIONS

- A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

Retain for projects with hydronic coils.

- B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties".

- C. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
- D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.5 IDENTIFICATION

- A. Label each air terminal unit with plan number, equipment tag number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

Retain for projects with hydronic coils.

- 2. **Hydronic Leak Test:** After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Air Leak Test: After installation, test and demonstrate that air terminal, and duct connections to air terminals are leak-tight.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.
- D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.

6. Verify that controls respond to inputs as specified.

3.8 FIELD QUALITY CONTROL

3.9 CLEANING

- A. Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturers touch-up paint. Clean entire unit of construction debris.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

PART 4 SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Air Terminal units: Shall be supplied with a minimum two row reheat coil when specified with integral reheat coils.

END OF SECTION 233600

KSU DESIGNERS NOTES:

1. KSU preference is for control valves / controllers to be shipped by the controls contractor to the terminal unit manufacturer for installation within the factory.
2. Review VAV terminal integral sound attenuators with KSU OUA for potential inclusion for supply and exhaust air terminals.
3. VAV Terminals shall be supplied with minimum, two row, and reheat coil. DDC controls unless existing systems are pneumatic, provide sound attenuators (if budget allows) and insulated box with antimicrobial lining using fiber lock type system, coordinate with KSU OUA.
4. Reheat to be hot water if central system if available and operates year round. Use fiber-free insulation when utilized for sound attenuator.
5. Electric reheat coils shall be PWM, multistage circuits. Associate to field verify building electrical and base selection on most energy efficient model. Use only after approval by KSU OUA.

No master specification section is provided for Breechings, Chimneys, and Stacks. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 235100 - BREECHINGS, CHIMNEYS AND STACKS

PART 1 - GENERAL

A. Codes and Standards

1. NFPA: Comply with NFPA 211 "Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances."
2. UL: Comply with applicable portions of UL Safety Standards; provide products which have been UL listed and labeled.
3. SMACNA: Comply with SMACNA 3rd addition Low Pressure Duct Standards 2005 for fabricated breaching and smoke pipe.
4. NEBB Duct leakage testing
5. Factory Mutual Standards.

PART 2 - PRODUCTS

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

KSU DESIGNERS NOTES:

1. All stack roof penetration details shall incorporate specific roof mfr. Requirements and be reviewed with OUA.
2. All breeching which have horizontal runs shall be tested for proper slope and cleanouts for any change in directions shall be reviewed with OUA.
3. Designs shall indicate engineered anchor points and expansion expectations.

4. Roof penetrations shall require full penetration detail on both the mechanical and coordinated into any architectural drawing were applicable. Flashing and counter flashing shall be coordinated with roof manufacturer were applicable to roof warranty.
5. All roof penetrations with hot ductwork or pipe shall be reviewed with OUA for approval.

END OF SECTION 235100

No master specification section is provided for Heating Boilers. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 235200 - HEATING BOILERS

PART 1 - GENERAL

PART 2 - PRODUCTS

- 2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- A. Gas fired pulse combustion boiler:
 - 1. Fulton
 - B. Gas Fired Condensing Boilers:
 - 1. Viessmann
 - 2. Weil-McLain
 - 3. Burnham
 - 4. Fulton
 - 5. Harsco Patterson Kelly
 - 6. AERCO
 - 7. Bosch
 - C. Gas Fired Cast Iron Boilers:
 - 1. Hydrotherm
 - 2. RBI
 - 3. Smith
 - D. Gas Fired Hot Water Boilers:
 - 1. PVI
 - 2. AERCO
 - 3. Lockinvar Powerfin
 - 4. A.O. Smith Shell & Tube
 - 5. RBI
 - 6. Discuss other manufacturers with OUA.
 - E. Electric Water Boilers:
 - 1. Consult with Kent State University and OUA for specific requirements.

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Equipment shall have electronic ignition in lieu of standing pilots.

KSU DESIGNERS NOTES:

- 1. Campus Steam (Kent campus Only) shall be utilized for heating and domestic water whenever feasible. Regional campuses shall be reviewed prior to design for type and utility service available.**
- 2. Where boilers are required, natural gas is the preferred fuel.**
- 3. Boilers shall be high efficiency and include all accessories and controls necessary to maximize efficiency within the constraints of the project budget.**
- 4. All boiler accessories shall be discussed with the University, describing benefits, disadvantages, efficiencies, etc.**
- 5. All boilers, heat exchangers, heat recovery units, etc. and their systems shall be reviewed with the OUA prior to determining manufacturers, system layouts or manufacturers which are to be specified. Consultants to avoid Aerco see boiler section below.**

END OF SECTION 235200

SECTION 235700 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes shell-and-tube heat exchangers.
- B. Section includes plate heat exchangers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Tube-removal space.
 - 2. Structural members to which heat exchangers will be attached.
- B. Seismic Qualification Data: Certificates, for heat exchanger, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Heat Exchanger: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of heat exchanger anchorage devices on which certification is based and their installation requirements.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic-water heat exchangers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 1. Structural failures including heat exchanger, storage tank, and supports.
 2. Faulty operation of controls.
 3. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.
 1. Shell-and-Tube, Heating Water Heat Exchangers:
 - 1) Tube Coil: One year.
 - 2) Other Components: One year.
 2. Plate, Domestic-Water Heat Exchangers:
 - 1) Brazed-Plate Type: One year.
 - 2) Plate-and-Frame Type: One year.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

Edit below if Seismic Requirements are applicable to the project

- A. Seismic Performance: Heat exchangers shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] **<Insert requirement>**.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
 2. Component Importance Factor is **[1.5] [1.0]**.
 3. **<Insert requirements for Component Amplification Factor and Component Response Modification Factor>**.

2.2 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Pumps, Inc.
2. ITT Corporation; Bell & Gossett.
3. Spirax Sarco, Inc.
4. TACO Comfort Solutions, Inc.

B. Description: Packaged assembly of tank, heat-exchanger coils, and specialties.

C. Construction:

1. Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

D. Configuration: U-tube with removable bundle.

KSU Preference is for Straight Tube with removable bundle where budget allows

E. Configuration: Straight tube with removable bundle.

F. Shell Materials: Steel.

G. Head:

1. Materials: Fabricated steel with side connections to heat exchanger (not end).
2. Flanged and bolted to shell.

H. Tube:

1. Seamless copper tubes.
2. Tube diameter is determined by manufacturer based on service.

I. Tubesheet Materials: Steel.

J. Baffles: Steel.

K. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges.

L. Support Saddles:

1. Fabricated of material similar to shell.
2. Fabricate foot mount with provision for anchoring to support.
3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger saddles are anchored to building structure.

- M. Capacities and Characteristics: Refer to Schedules on Drawings.

2.3 GASKETED-PLATE HEAT EXCHANGERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alfa Laval Inc.
 2. Polaris Heat Exchangers.
 3. TACO Comfort Solutions, Inc.
 4. Wessels Company.
- B. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets. Include leak chamber with relieving grooves.
- C. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

Watch physical dimensions with requirement below for 20% additional plates. Typically don't include fouling factor for plate frame heat exchangers.

- D. Frame:
1. Capacity to accommodate 20 percent additional plates.
 2. Painted carbon steel with provisions for anchoring to support.
- E. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.
1. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger carrying and guide bars are anchored to building structure.
- F. End-Plate Material: Painted carbon steel.
- G. Tie Rods and Nuts: Steel or stainless steel.
- H. Plate Material: 0.5mm thick before stamping 150 psi rating, 0.6mm for 300 psi rating; Type 304 or Type 316 stainless steel.
- I. Gasket Materials: Glue free Nitrile butyl rubber for applications up to 284°F or EPDM for up to 320°F.
- J. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges.
- K. Enclose plates in solid aluminum removable shroud.

- L. Capacities and Characteristics: Refer to Schedule on Drawings.

2.4 BRAZED-PLATE HEAT EXCHANGERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alfa Laval Inc.
 - 2. Polaris Heat Exchangers.
 - 3. TACO Comfort Solutions, Inc.
- B. Configuration: Brazed assembly consisting of embossed or pressed stainless-steel plates brazed together and two end plates, one with threaded nozzles and one with pattern-embossed plates.
- C. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.
- D. End-Plate Material: Type 316 stainless steel.
- E. Threaded Nozzles: Type 316 stainless steel.
- F. Plate Material: Type 316 stainless steel.
- G. Brazing Material: Copper.
- H. Capacities and Characteristics: Refer to schedules on drawings.

2.5 ACCESSORIES

- A. Hangers and Supports:
 - 1. Custom, steel cradles for mounting on structural steel.
- B. Shroud: Aluminum sheet for plate heat exchangers.

2.6 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect heat exchangers according to ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME label.
- B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.
- C. Heat exchangers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
- B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SHELL-AND-TUBE HEAT-EXCHANGER INSTALLATION

- A. Equipment Mounting:
 - 1. Install heat exchangers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in 230501.
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Install heat exchangers on saddle supports.
- C. Heat-Exchanger Supports: Use factory-fabricated steel cradles and supports specifically designed for each heat exchanger.

3.3 GASKETED-PLATE HEAT-EXCHANGER INSTALLATION

- A. Install gasketed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.
- B. Install metal shroud over installed gasketed-plate heat exchanger according to manufacturer's written instructions.

3.4 BRAZED-PLATE HEAT-EXCHANGER INSTALLATION

- A. Install brazed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.

3.5 CONNECTIONS

- A. Comply with requirements for piping specified in other Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
- C. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.
- D. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.
- E. Install shutoff valves at heat-exchanger inlet and outlet connections.
- F. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.
- G. Install vacuum breaker at heat-exchanger steam inlet connection.
- H. Install hose end valve to drain shell.
- I. Install thermometer on heat-exchanger and inlet and outlet piping, and install thermometer on heating-fluid inlet and outlet piping. Comply with requirements for thermometers specified in Section 230519 "Meters and Gages for HVAC Piping."
- J. Install pressure gages on heat-exchanger and heating-fluid piping. Comply with requirements for pressure gages specified in Section 230519 "Meters and Gages for HVAC Piping."

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Heat exchanger will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Heat exchanger concrete bases:
 - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - 2. Construct bases to withstand, without damage to equipment, seismic force required by code.
 - 3. Construct concrete bases 4 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of heat exchangers unless otherwise indicated or unless required for seismic anchor support.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Installation Requirements:
 - 1. Heat exchangers shall be mounted with adequate access for tube pull, cleaning and tube replacement.
 - 2. Heat exchanger supports shall be painted with primer and two coats of enamel paint.
 - 3. Taps with ball valves and capped hose connections shall be installed on the equipment side of the isolation valves for the purpose of circulating chemical cleaners through individual exchangers.
 - 4. Thermometers and pressure gauges shall be installed on the inlets and outlets of water piping and pressure gauges on inlet of steam piping.

END OF SECTION 235700

KSU DESIGNERS NOTES:

- 1. Heat exchangers for building heat shall be installed in fully redundant pairs whenever possible. Valving shall be installed to facilitate concurrent cleaning of one unit while the other is in operation. Utilize 1/3-2/3 steam supply piping and valve arrangement.
- 2. Utilize a dual steam trap design for steam condensate.
- 3. Heat exchangers for heating domestic hot water shall have a straight through tube arrangement to allow for tube cleaning from both ends.

4. Heat exchangers for hydronic heating also will have straight tubes as the preferred arrangement if budget allows otherwise u-tube are acceptable.
5. Use optimal Maximum tube thickness for system longevity.
6. Coordinate and detail mounting height of heat exchangers with respect to steam outlet and inlet to condensate receiver. Steam condensate piping from outlet of heat exchanger is not to be lifted!
7. All boilers, heat exchangers, heat recovery units, etc. and their systems shall be reviewed with the OUA prior to determining manufacturers, system layouts or manufacturers which are to be specified. Consultants to avoid Aerco see boiler section below.

No master specification section is provided for Packaged Compressor and Condensing Units. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 Codes and Standards

- A. Capacity ratings for condensing units shall be in accordance with ARI Standard 360 "Standard for Commercial and Industrial Unitary Air Conditioning Equipment."
- B. Refrigeration system of condensing units shall be constructed in accordance with ASHRAE Standard ASHRAE 15 & 34 "Safety Code for Mechanical Refrigeration."
- C. Condensing units shall meet or exceed the minimum COP/Efficiency levels as prescribed in ASHRAE 90.1 "Energy Conservation in New Building Design."
- D. Condensing units shall be listed by UL and have UL label affixed.

1.2 Warranty

- A. Provide written material and labor warranty (five year), signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only; include labor for removal and reinstallation. All refrigeration equipment shall include a complete refrigerant charge by the installing contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Air Conditioning; Div. of Carrier Corp.
 - 2. Daikin(McQuay) Air Conditioning Group; Daikin(McQuay), Inc.
 - 3. Trane (The) Co; Div. American Standard, Inc.
 - 4. Johnson Controls(York) (Base specification)

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. All condensing units shall include low and high pressure cut out controls.

KSU DESIGNERS NOTES:

- 1. Provide for low ambient operation control or automatic low ambient lock out as required.**
- 2. Provide convenience lighting and GFCI receptacles for service. Coordinate with KSU OUA.**

END OF SECTION 236200

No master specification section is provided for Air Cooled Condensers. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 236313 - AIR COOLED CONDENSERS

PART 1 - GENERAL

1.1 Codes and Standards

- A. Air cooled condensers shall meet or exceed the minimum COP/Efficiency levels as prescribed in ASHRAE 90A "Energy Conservation in New Building Design."
- B. Air cooled condensers shall be listed by UL and have UL label affixed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Air Conditioning; Div. of Carrier Corp.
 - 2. Daikin(McQuay) Air Conditioning Group; Daikin(McQuay), Inc.
 - 3. Trane (The) Co; Div. American Standard, Inc. (not to be selected at this time)
 - 4. Johnson Controls (Base specification)

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Rooftop condensers shall match the compressor equipment.

KSU DESIGNERS NOTES:

1. Roof mounted equipment shall be mounted such that the roof may be maintained below the unit. For larger equipment, the unit shall be mounted minimum 24" preferred, above the roof. Utilize full perimeter roof curb where appropriate to eliminate roof maintenance below unit.
2. Equipment shall be mounted such that there is a minimum of ten feet to the edge of any drop-off or roof edge (unless otherwise approved by OUA). Review fall protection requirements with KSU OUA.
3. Ground mounted equipment shall be mounted on a reinforced concrete pad designed to support the weight of the unit.
4. Ground mounted equipment shall be located to minimize public access by location or by installation of a visual barrier, review with KSU OUA.

END OF SECTION 236313

No master specification section is provided for Packaged Water Chillers. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 236433 - PACKAGED WATER CHILLERS

PART 1 - GENERAL

1.1 Codes and Standards

- A. ARI Compliance: Test and rate reciprocating chillers in accordance with ARI STD 590, "Standard for Reciprocating Water Chilling Packages."
- B. ASHRAE Compliance: Fabricate and install chillers in accordance with ASHRAE STD 15, "Safety Code for Mechanical Refrigeration." Provide Energy Efficiency Ratio (EER) for reciprocating chillers not less than prescribed by ASHRAE Std 90A, "Energy Conservation in New Building Design."
- C. NEMA Compliance: Provide high-efficiency motors for reciprocating chillers which comply with NEMA Stds. Pub/No.'s MG 1, 2, 3, 10 and 11.

1.2 Warranty

- A. All reciprocating compressors shall carry a minimum of a five (5) year parts and labor warranty.

PART 2 - PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

A. Centrifugal and Reciprocating Equipment:

- 1. Carrier
- 2. Daikin(McQuay)
- 3. JCI/York
- 4. Trane

B. Screw Equipment:

- 1. Carrier
- 2. Daikin
- 3. Dunham Bush
- 4. JCI/York
- 5. Trane

C. Absorption Equipment:

- 1. Carrier

2. Daikin
3. JCI/York
4. Trane

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Access shall be maintained for unrestricted removal of the tubes.
- C. The chiller controls shall enable chilled water reset by the energy management system and monitoring/control of most other chiller functions.
- D. Chillers shall be mounted on a 4" high (minimum) chamfered reinforced concrete housekeeping pad.
- E. Provide chiller barrels with anode rods.

KSU DESIGNERS NOTES:

1. Targeted Phase-out HCFC's shall not be allowed in any new chillers.
2. Review chiller type (absorption, electric, steam, magnetic or multistack, etc.) with KSU OUA.
3. The majority of chiller equipment installed on Kent campus is Trane and York.
4. The University is continually searching for methods to reduce energy costs on the campus; therefore, the Associate shall consider lowest KW/Ton efficiency and sound power levels. Thermal energy storage systems should also be considered on all projects with chillers 100 tons or larger if budget allows. Lift cycle cost analysis shall be required for equipment selection on units above 100 tons.
5. Marine water boxes are the preferred connection method.
6. The consultant shall plan for future removal of the chiller by providing removable access panels, adequately sized equipment wells, aisles, etc.
7. Piping shall be designed and installed in a manner to enable the annual cleaning of the tubes with system still operational as applicable. Coordinate with KSU OUA.
8. Heat rejection chillers shall be reviewed with OUA prior to selecting or designing this type of equipment.
9. Magnetic Chillers shall be reviewed with OUA prior to selecting or designing this type of equipment.

10. Heating and cooling chillers shall be reviewed with OUA prior to selecting or designing this type of equipment.

END OF SECTION 236433

No master specification section is provided for Cooling Towers. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 236500 - COOLING TOWERS

PART 1 - GENERAL

1.1 Codes and Standards

- A. UL and NEMA Compliance: Provide electric motors and electrical components required as part of factory fabricated cooling towers which have been listed and labeled by UL and comply with NEMA Standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Marley (Preferred)
 - 2. Baltimore Air Coil
 - 3. Evapco
 - 4. Tower Tech and Delta (Review with OUA)

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Cooling towers shall be provided with distribution basin covers.
- C. Provide mist and drift eliminators.
- D. Cooling tower design and construction shall include an access ladder to the hot basin and fans. The ladder shall include guards to prevent injury due to falling.
- E. Makeup float valve shall be 1¼" minimum.

KSU DESIGNERS NOTES:**1. Tower performance**

- A. Tower performance will need to be reviewed with OUA. Base of design should meet 95 deg DB with 87 deg WB for ambient conditions. Water temperature performance should be based on 85 deg LWT and 95 deg EWT for normal application. Towers associated with steam drive chillers or elevated equipment discharge temperatures should be accounted for in the towers performance and tower fill.**
- B. High efficiency motors shall be considered since designs are to incorporate VFD for fan speed control. Gear drives shall be considered and provided as base of design. Alternate for going with belt or direct drive units.**
- C. Tower level controls shall be reviewed with OUA design with digital control preferred and programmed for JCI controls interface. Each cell shall be supplied with level device. Other methods of unit's make-up water system shall be reviewed with OUA engineers.**
- D. All towers selections and designs with require consultant to provide lift cycle cost analysis as part of equipment selection.**
- E. All cooling towers shall be stainless steel construction unless written approval by OUA to construct in another material type. Galvanized steel construction shall be avoided.**

- 2. The consultant shall review each of the manufacturers for size when developing the design documents.**
- 3. If budget allows, an indoor sump tank is preferred in order to conserve water, electricity and chemical treatment.**
- 4. The towers shall be mounted on structural steel, primed and painted with coats of quality exterior grade paint. If budget allows, the towers shall be mounted on galvanized steel support. Towers hot basin and cold basin and wetted surfaces to be stainless steel. PVC honey comb fill is preferred and shall be rated for 115 deg. Review with KSU OUA.**
- 5. Roof mounted cooling towers shall be mounted a minimum of 24" above the roof (24" to lowest portion of support steel) to facilitate future roof work.**

6. Tower makeup lines shall have a winter shutoff valve located such that the tower lines can easily be drained to avoid freezing. Makeup float valve shall be 1¼" minimum. If towers are to be used for winter operation the winter mode of operation shall be reviewed in detail with OUA.
7. Open tower system piping shall be a non-ferrous pipe such as fiberglass, PVC, or ABS. This eliminates the continual cleaning problems associated with rust flaking in steel piping. Thrust restraints shall be incorporated into the piping design.
8. Cooling tower fan shall be controlled by a frequency drive whenever possible. Two speed fans shall have a soft start on the low speed as a minimum. Two speed fans should only be considered if budget is concern. Review with OUA prior to making this decision.
9. Cooling towers for absorption chillers shall include a tower water bypass for control of condenser water temperature at initial startup. Water must be bypassed to the tower cold basin. Review design needs with OUA.
10. Cooling tower sump outlet shall be a minimum of 48" higher than the suction inlet of the tower water pump.

END OF SECTION 236500

No master specification section is provided for Central HVAC Equipment. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 237000 - CENTRAL HVAC EQUIPMENT

PART 1 - GENERAL

1.1 Codes and Standards

- A. AMCA Compliance: Test and rate air handling units in accordance with AMCA standards.
- B. ARI Compliance: Test and rate air handling units in accordance with ARI 430 "Standard for Central Station Air Handling Units;" display certification symbol on units of certified models.
- C. NFPA Compliance: Provide air handling unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50, and complying with NFPA 90A "Standard for the Installation of Air Conditional and Ventilating Systems."
- D. Systems shall meet or beat ASHRAE 90.1 and comply with ASHRAE 62.1, 2004 guide lines.

1.2 Extra Materials

- A. Extra Stock: The contractor shall supply one complete set of filters and belts at the close of the project. Where the unit has pre-filters and final filter, provide both spare sets. If used during construction the contractor shall furnish prefilters, filters and final filters to ensure equipment is protected from dust, MERV rating of 13 is the minimum filtration during the use under construction phase. Cost of filter change out shall be borne by the contractor and not the owner.

PART 2 - PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

A. Preferred Manufacturers (Pre-Built):

- 1. Trane
- 2. Carrier
- 3. JCI/York
- 4. Daikin(McQuay)
- 5. Aeon (Prior approval required)
- 6. Petra (Prior approval required)
- 7. Air Enterprise
- 8. Buffalo Air Handling
- 9. Governair LLC
- 10. Reznor
- 11. Temtrol Inc.

B. Preferred Manufacturers (Custom), if others review with OUA:

1. Air Enterprise
2. Engineered Air
3. Governair
4. Buffalo
5. JCI /York Custom
6. Trane
7. Temtrol Inc.

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Exterior units shall have sloped horizontal surfaces to shed water.
- C. Louvers: Utilize drainable, sight proof with removable bird screens, custom Kynar finish (color by A/E), velocity to minimize water and snow penetration, complete perimeter caulk/sealant both sides, coordinate with A/E and General Contractor. Design shall provide access between OA damper assembly and insect screen on louvers.
- D. Casing: 2" insulated double wall aluminum or galvanized steel wall panels. Provide hinged access doors with cam lock handles and view window where required for maintenance. Provide interior fluorescent lighting as needed with on/off switch. Switch to include long lasting (LED or Neon) pilot light "on" indication and accessory GFCI receptacle.
- E. Fans: Include vibration isolation; VFD duty motors, grease lubricated long life bearings with lube lines extended to access side of unit with plastic tubing and zerk fittings.
- F. Dampers: Provide low leakage dampers with damper blade orientation to facilitate air blending and minimize stratification. Damper actuators shall be by JCI or approved equal.
- G. Coils: All piping and valving arrangements to allow coil removal.
 1. Preheat:
 - a. VIFB coil with redundant double steam trap arrangement (when steam is utilized).
 - b. Provide control valve with bypass.
 2. Cooling:

- a. Provide minimum 1/2" O.D., 0.030" wall copper thickness with 0.01" minimum aluminum fins, maximum 11 fins per inch.
 - b. Maximum 500 fpm face velocity.
 - c. Stainless steel coil casing, maximum 6 row coils (where feasible).
3. Drain Pans:
- a. Stainless steel IAQ insulated double wall construction condensate drain pans (stacked coils with intermediate pans).
 - b. Slope drain pans for complete drainage to accessible side of unit.
4. Heating/Reheat:
- a. Provide minimum 5/8" O.D. tubes, 0.030" wall copper thickness with 0.01" minimum aluminum fins, maximum 11 fins per inch.
- ~~H. Ultraviolet lamp sterilization: Provide on outlet side of cooling coils.~~ **Needlepoint Bipolar Ionization (NPBI.) Provide Global Plasma Solutions Brand and install on the inlet side of the cooling coil. NPBI alarm connections shall be connected and programmed to alarm through the BAS.**
- I. The contractor shall be responsible for filter maintenance if the unit is used for ventilation purposes while construction continues. The filter media shall be of a MERV 13 rating. Additional filtration to prevent debris entering duct systems must be included. This would include all outside air intakes, return air grilles or registers which could be subject to contamination due to area construction. Contractor to complete thorough cleaning of unit prior to acceptance of unit.
- J. The contractor shall replace all filters prior to balancing of the project.
- K. Test holes shall be provided at each section of air handlers for testing purposes. The test slots shall include a screwed cap to minimize air leakage.

KSU DESIGNERS NOTES:

- 1. Air handling units shall be located in a completely enclosed mechanical room whenever possible. Roof and ground mounted equipment is unacceptable unless approved by OUA.**
- 2. Units shall be mounted on appropriate equipment bases or housekeeping pads.**
- 3. Adequate space shall be provided for coil replacements. Coil pull space shall be indicated on the construction documents.**
- 4. The Engineer shall design installation with future replacement of the unit in mind.**
- 5. Design shall provide access between OA damper assembly and insect screen on louvers.**
- 6. Use of air handling unit for temporary ventilation during construction must be reviewed on project by project basis with the OUA.**

7. Access to the filters shall be made without the use of tools wherever possible.
8. Larger air handling units (greater than 10,000 CFM) shall include a pre-filter section and a bag filter section. Review filters selection and efficiency with OUA. Filters to have a minimum of 30% pleated MERV 8 rating. Lab and research centers shall be equipped with MERV 8 pre-filter and MERV 13 or higher final filter. Lab and research building shall be reviewed with OUA for filter requirements of HVAC equipment. Include a differential pressure sensing device across the filter. Review communications requirements with OUA. Sensors shall be compatible with Johnson Controls Metasys.
9. Generally, all air handling units shall include outside air economizer, CO2 sensors, internal face and bypass, VIFB coils when possible, unless otherwise approved. Damper actuators to be by JCI or equivalent and on custom units JCI or equivalent shall provide dampers and actuators. Access doors shall be provided with windows and interior lighting where possible, double wall construction. Only select units with the highest quality of components.
10. Provide units with energy recovery where possible. Units shall be sized for economizer consideration.
11. Prefer steam VIFB coil with redundant double steam trap arrangement.
12. Humidification: Steam dispersion tube type with rapid absorption characteristics when required. Coordinate with OUA prior to equipment selection. Air handling units shall include humidifying systems when applicable and approved by KSU OUA. Utilize steam for pre-heat coils, galvanized steel coil casing shall be avoided, where possible. Stainless steel is preferred when budget allows. Review with OUA.
13. Fans: University preference is for direct drive fans wherever possible.
14. Fan Walls: Can be considered, review with KSU OUA.
15. Unit wiring shall be by manufacturer with single point wiring connection complete with separate circuit for controls.
16. Controls: See Division 25 INTEGRATED AUTOMATION.

END OF SECTION 237000

No master specification section is provided for Variable Speed Drives. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 237100 - VARIABLE SPEED DRIVES (VSD)

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 Manufacturers

1. ABB.
2. Allen Bradley.
3. Danfoss.
4. Square D.

Exception to these manufacturers have to be reviewed with OUA and only if part of an OEM packaged system not offering one of KSU preferred vendors.

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. All drives shall be provided with manual by-pass features, BACnet IP, MS/TP, N2 Communications for integration with Johnson Controls Metasys Building Automation System.
- C. All drives are to be provided with Front Panel Displays (HMI) including password protection feature which need to be reviewed with OUA.
- D. Displays must have the following:
 1. Output Frequency (HZ)
 2. Speed (RPM)
 3. Motor Current
 4. Calculated Motor Torque (%)
 5. Calculated Motor Power (kw)
 6. DC Bus voltage, Output voltage
 7. Resettable time meter

8. KWH meter (resettable)
9. Error and Fault text notification
10. PID actual value (feedback) and error messaging

E. Provide with the following capabilities:

1. Auto restart (reset) selectable and adjustable by KSU.
2. Programmable analog, digital inputs and outputs (number to be reviewed with OUA).
3. Input Speed Signals 4-20 ma or 0 to 10 v complete with increase/decrease reference contacts, serial communications.

KSU DESIGNERS NOTES:

1. All Drives are to be housed in the proper NEMA enclosure for the environment in which the unit is to be placed. High ambient temperature relating to mechanical or equipment rooms shall be reviewed with OUA and project architect.
2. All drive applications Sequence of Operations for chillers, air handling units, cooling tower pump control, domestic water booster pump control, hydronic pump control and all type of fans or fan wall systems.
3. Review the following with OUA Engineers:
 - a. Type of Human Machine Interface (HMI) display, terminal block options, and communications packages and drive protection features. All of these key items can be project specific and have to be review with both OUA electrical and mechanical engineers.
 - b. PID Controls, Motor control features, Preprogrammed Protection circuits, programmable fault functions and protection options.
 - c. Start/ Stop functions, review contact number and reference signal communication features.
 - d. Fire alarm control input features and fire alarm contractor prior to ordering final unit for KSU projects.
 - e. Start Function on Ramping, auto torque etc. based on system applications.
4. Final review of manufacturer options which are not part of the required information provided above shall be reviewed with both OUA mechanical and electrical engineers.

END OF SECTION 237100

No master specification section is provided for Decentralized HVAC Equipment. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 238000 - DECENTRALIZED HVAC EQUIPMENT

PART 1 - GENERAL

1.1 Codes and Standards

- A. I=B=R Compliance: Test and rate baseboard and finned tube radiation in accordance with I=B=R, provide published ratings bearing emblem of I=B=R.

PART 2 - PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

A. Finned Tube Radiation:

- 1. No specifically preferred manufacturer. Review with OUA.

B. Electric Baseboard Radiation:

- 1. No specifically preferred manufacturer.
- 2. Please coordinate and get OUA Approval prior to listing base of design.

C. Radiant Ceiling Panels:

- 1. Aerotec.
- 2. Airtex.
- 3. Sun-el.

D. Convectors:

- 1. No specifically preferred manufacturer.
- 2. Airtherm.
- 3. JCI York.
- 4. Runtal.
- 5. Sterling.
- 6. Trane.
- 7. Vulcan.

E. Fan Coil Units:

1. IEC.
2. Nailor.
3. Daikin.
4. Trane.

F. Unit Ventilators:

1. Daikin.
2. IEC.
3. Trane.
4. Others shall be reviewed with OUA

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.

KSU DESIGNERS NOTES:

1. Finned Tube Radiation:

- a. Radiation covers shall include manual dampers with occupant accessible operation and slant top housing design/pencil proof design. Review with OUA.

2. Electric Baseboard Radiation:

- a. Electric baseboard in occupied areas shall include accessible temperature control and on/off switch and BAS controls.

3. Radiant Ceiling Panels:

- a. Provide BAS seq. of operations, panels shall be coordinated into reflected ceiling system and panels shall have insulation installed above units as determined by manufacturer.

4. Fan Coil Units:

- a. Coordinate control seq. of operations and configuration with OUA.
- b. Provide 4-pipe system when applicable to building systems. Units to be supplied with motorized O.A. damper controls, prepiped with isolation 1/4" turn ball valves, plastic or stainless steel A/C condensate drain pans, pleated filters, circuit setter and control valve coordinated with BAS.

c. Unit control shall allow full communication with KSU BAS.

5. Unit Ventilator:

a. Provide 4-pipe system when acceptable to building conditions. Unit to be furnished with bar grilles, microprocessor controlled, insulated unit construction, plastic or stainless steel condenser drain pans, motorized face and bypass damper controls, OA temperature sensor and freeze protection. If DX cooling system to have low ambient lockout controls, hot gas bypass and economizer. Unit control shall allow full communication with KSU OUA. Associate to use hot water and chilled water coils when available. DX systems must be approved by KSU OUA. Unit Ventilators:

END OF SECTION 238000

No master specification section is provided for Computer Room Air Conditioners. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 238123 - COMPUTER ROOM AIR CONDITIONERS

PART 1 - GENERAL

1.1 Warranty

- A. Provide with 5 year parts and labor refrigeration warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Liebert/Emerson
 - 2. Data Aire

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Each unit to be furnished with:
 - 1. Micro base unit controls, BACnet interface capability with Johnson controls.
 - 2. Humidifier with infrared lamp (setpoint based on room conditions with range 35% to 55% RH) self contained system.
 - 3. Dual refrigeration circuits and compressors, CFC refrigerant system based on EPA class 2 or better for clean air act.
 - 4. Water leak detection system for raised floor applications.
 - 5. High efficiency units.

KSU DESIGNERS NOTES:

1. **Provide with DX, glycol or chilled water coils (review this option with OUA)**

END OF SECTION 238123

No master specification section is provided for Tele/Data Room Air Conditioners. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 238124 - TELA/DATA ROOM AIR CONDITIONERS

PART 1 - GENERAL

1.1 Warranty:

- A. Provide units with 5 year parts and 1-year labor warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Sanyo – ECO-I
 - 2. Daikin
 - 3. LG - Multi V
 - 4. Mitsubishi - CITY MULTI (PREFERRED VENDOR)
 - 5. Mitsubishi - MR. SLIM

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Each unit to be furnished with micro base unit controls, BACnet interface capability with Johnson controls.
- C. CFC refrigerant system based on EPA class 2 or better for clean air act.
- D. Provide with a/c leak detection system.
- E. High efficiency units.

KSU DESIGNERS NOTES:

- 1. VRF systems to have A410 refrigerant, (review this options with OUA)**

END OF SECTION 238124

No master specification section is provided for VRF Heating and Cooling Systems. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 238124 - VRF HEATING AND COOLING SYSTEMS

PART 1 - GENERAL

1.1 Warranty:

- A. Provide units with 5 year parts and 1-year labor warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Daikin
 - 2. LG - Multi V
 - 3. Mitsubishi - CITY MULTI (PREFERRED VENDOR)
 - 4. Sanyo – ECO-i

PART 3 - EXECUTION

3.1 Training:

- A. Training on system will include system setup, wiring of system, sequence of operation, refrigerant quantity and verification, control sequence and numbering of circuits. Complete O&M manuals of system including any support software. Software license shall be good for five years from date of installation.

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Each unit to be furnished with:

1. Micro base unit controls, BACnet interface capability with Johnson controls.
 2. CFC refrigerant system based on EPA class 2 or better for clean air act.
 3. A/C leak detection system.
 4. High efficiency units.
- C. Outdoor units shall be provided with hail guards for protection of coils.
- D. VRF systems shall also be provided with all support maintenance devices for field diagnostics so technical are equipment with interface panel, handheld devices etc. These components shall be built into the specifications and issued as an alternate to the contract documents.

KSU DESIGNERS NOTES:

1. VRF system to have A410 refrigerant, (review this options with OUA)
2. Each of the designs shall utilize state of the art A/C condensate pumps and the pumping system shall have the ability to shut down the units if drain pans are overloaded and not draining.
3. The refrigeration systems shall also be provided with isolation valving to ensure that maintenance personnel can isolate each of the system refrigerant lines from both the distribution unit and also at the terminal unit.
4. All outside equipment will be provided with support structure to account for snow loading and be equipped with freeze, ice and snow protection for lower sections of condensing units. Systems which require cooling in winter mode of operation shall also be provided with low ambient controls.
5. The system design for a building layout shall be reviewed with OUA.

END OF SECTION 238124

SECTION 238239.13 - CABINET UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

Retain only heating coil type applicable to project here and in from Part 2 as well.

- A. Section includes cabinet unit heaters with centrifugal fans and [hot-water] [steam] [electric-resistance heating] coils.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. DDC: Direct digital control.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, accessories, and wiring diagrams.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which cabinet unit heaters will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:

- a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
6. Perimeter moldings for exposed or partially exposed cabinets.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- B. Seismic Qualification Data: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:
- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide **hydronic** or **steam** cabinet unit heaters by one of the following:
- 1. Airtherm.
 - 2. Daikin.
 - 3. Dunham Bush

4. JCI.
5. Rittling.
6. Sterling.
7. Trane.
8. Vulcan Radiator Corp.

B. Manufacturers: Subject to compliance with requirements, provide electric cabinet unit heaters by one of the following:

1. Chromalox.
2. INDEECO.
3. Markel Products; TPI Corporation.
4. Marley Engineered Products.
5. QMark; Marley Engineered Products.

2.2 DESCRIPTION

- A. General: Provide cabinet heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, and insulation.
- B. Factory-assembled and -tested unit complying with AHRI 440.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Retain paragraph below for electric cabinet unit heaters.

- D. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- C. Seismic Performance: Cabinet unit heaters shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

2.4 COIL SECTION INSULATION

- A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have aluminum-foil facing to prevent erosion of glass fibers.
1. Thickness: 1/2 inch.
 2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 CABINETS

Specifier to select from options below for cabinet finish type.

- A. Material: Steel with [factory prime coating, ready for field painting] [baked-enamel finish with manufacturer's standard paint, in color selected by Architect] [baked-enamel finish with manufacturer's custom paint, in color selected by Architect].
1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch(16 gauge) thick cold rolled sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners. Top and side panels to be 18 gauge.
 2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch(16 gauge) thick cold rolled sheet steel, removable panels secured with tamperproof cam fasteners and safety chain. Sides of unit to be 18 gauge.
 3. Piping Compartment: Standard 7-1/2-inch- wide piping end pocket.

2.6 FILTERS

- A. Minimum Efficiency Reporting Value: According to ASHRAE 52.2.
- B. Material: Pleated cotton-polyester media, MERV 7.

2.7 COILS

- A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- B. Steam Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 75 psig.
- C. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

2.8 CONTROLS

A. Fan and Motor Board: Removable.

Retain high static option below when necessary to overcome ductwork / system pressure losses.

1. Fan: Forward curved, **[high static]**, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.

Specifier to select from the options below for motors. EC motors have nearly double the expected life but will add about 25% to the equipment cost.

2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. High efficiency Electronically Commutated Motors (ECM) utilizing brushless DC motors coupled with an interface solid state control board and a three speed switch that provides speed control of the motors.
4. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.9 ACCESSORIES

A. Accessories: Provide the following accessories as indicated and/or scheduled:

Retain "Recessed Flanges" Subparagraph below for units that are semi-recessed or fully recessed in walls or ceilings

1. Recessed Flanges: Steel, finished to match cabinet.

Retain below for secure areas. Coordinate with Owner.

2. Control Access Door: Key operated.

Retain "Base" Subparagraph below for surface, vertical, wall-mounted units

3. Base: Minimum 0.0528-inch-thick (18 gauge) steel, finished to match cabinet, 4 inches high with leveling bolts.
4. Plate mounted 24VAC 40VA transformer and a 4x4 junction box for low voltage thermostat.
5. Disconnect Switch: Provide factory-mounted and wired disconnect switch.

2.10 Basic Unit Controls:

1. Control voltage transformer.
2. Manual fan-three speed switch.
3. Aquastat.
4. **[Wall] [Unit]**-mounted low voltage thermostat with the following features:
 - a. Heat-off switch.
 - b. Adjustable deadband.
 - c. **[Concealed] [Exposed]** set point.
 - d. **[Concealed] [Exposed]** indication.
 - e. Deg F indication.

B. Electrical Connection: Factory-wired motors and controls for a single field connection.

2.11 CAPACITIES AND CHARACTERISTICS

Select from configurations below to suit project.

A. Cabinet:

1. Vertical, Surface Mounted: Upflow.
 - a. Top: [Flat] [Sloped] [Flat or sloped].
 - b. Air Inlet: [Open bottom] [Front, punched louver] [Front, extruded-aluminum bar grille].
 - c. Air Outlet: [Front] [Top] [Front or top], [quad louver] [punched louver] [extruded-aluminum bar grille].
2. Vertical, Surface Mounted: Downflow.
 - a. Top: [Flat] [Sloped] [Flat or sloped].
 - b. Air Inlet: [Front] [Top] [Front or top], [punched louver] [extruded-aluminum bar grille].
 - c. Air Outlet: Front, [quad louver] [punched louver] [extruded-aluminum bar grille].
3. Vertical, Semirecessed: Upflow.
 - a. Air Inlet: [Open bottom] [Front, punched louver] [Front, extruded-aluminum bar grille].
 - b. Air Outlet: [Front] [Top] [Front or top], [quad louver] [punched louver] [extruded-aluminum bar grille].
4. Vertical, Semirecessed: Downflow.
 - a. Air Inlet: [Front] [Top] [Front or top], [punched louver] [extruded-aluminum bar grille].
 - b. Air Outlet: Front, [quad louver] [punched louver] [extruded-aluminum bar grille].
5. Vertical, Fully Recessed: [Upflow] [Downflow].
 - a. Air Inlet: [Front] [Duct connection], [punched louver] [extruded-aluminum bar grille].
 - b. Air Outlet: [Front] [Duct connection], [quad louver] [punched louver] [extruded-aluminum bar grille].
6. Horizontal, Surface Mounted:
 - a. Air Inlet: [Bottom] [Front] [Bottom or front], [punched louver] [extruded-aluminum bar grille].
 - b. Air Outlet: [Front] [Top] [Front or top], [quad louver] [punched louver] [extruded-aluminum bar grille].
7. Horizontal, Semirecessed:

- a. Air Inlet: [Bottom] [Front] [Bottom or front], [punched louver] [extruded-aluminum bar grille].
 - b. Air Outlet: [Front] [Top] [Front or top], [quad louver] [punched louver] [extruded-aluminum bar grille].
8. Horizontal, Fully Recessed:
- a. Air Inlet: [Front] [Duct connection], [punched louver] [extruded-aluminum bar grille].
 - b. Air Outlet: [Front] [Duct connection], [quad louver] [punched louver] [extruded-aluminum bar grille].
- B. Concealed Unit Heater:
- 1. Vertical: [Upflow] [Downflow].
 - a. Air Inlet: [Open bottom] [Front, punched louver] [Front, extruded-aluminum bar grille].
 - b. Air Outlet: [Front] [Top] [Front or top], [quad louver] [punched louver] [extruded-aluminum bar grille].
 - 2. Horizontal: Upflow.
 - a. Air Inlet: [Open bottom] [Front, punched louver] [Front, extruded-aluminum bar grille].
 - b. Air Outlet: [Front] [Top] [Front or top], [quad louver] [punched louver] [extruded-aluminum bar grille].

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install unit heaters as indicated, and in accordance with manufacturer's installation instructions.
- B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

- C. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated.
- D. Support units with rod-type hangers anchored to building substrate.
- E. Install piping as indicated.
- F. Protect units with protective covers during balance of construction.
- G. Note limitations on vertical space above ceilings and above doors.
- H. Equipment Mounting:

Select from the two paragraphs below. First paragraph is for projects with Seismic requirements.

- 1. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 2. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Section 230548.13 "Vibration Controls for HVAC."
- I. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
 - J. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," Section 232116 "Hydronic Piping Specialties," Section 232213 "Steam and Condensate Heating Piping," and Section 232216 "Steam and Condensate Heating Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
- D. Comply with safety requirements in UL 1995.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

END OF SECTION 238239.13

KSU DESIGNERS NOTES:

1. Valves for wall mounted cabinet unit heaters to be installed in an accessible location in the ceiling space in lieu of unit cabinet due to difficulty of installation and servicing. Install drain valves cabinet unit heater for draining purposes.
2. KSU Preference is for ECM motors on cabinet unit heaters. Coordinate with KSU project manager.
3. Use sloped top fan coil units within offices and other areas where people may store items on top of fan coil units.
4. Insure wall cavities behind cabinet unit heaters on exterior walls are insulated to minimize risk of freezing piping systems.
5. Coordinate thermostat and wiring to be by the TCC. Integral valve packages from manufacturer not an option.
6. Coordinate with wall finish and architects for final selection and review control seq. of operation with JCI and OUA.
7. Provide with speed control and temperature control device suited for building application and fan cycling to minimize fan energy when temperatures are satisfied.

SECTION 238239.16 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

Retain only heating coil type applicable to project here and in from Part 2 as well.

- A. Section includes propeller unit heaters with [hot-water] [steam] [electric-resistance heating] coils.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. PTFE: Polytetrafluoroethylene plastic.
- C. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, accessories, and wiring diagrams.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which propeller unit heaters will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.

- c. Speakers.
- d. Sprinklers.
- e. Access panels.

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- B. Seismic Qualification Certificates: Submit certification that propeller unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, provide **hydronic** or **steam** unit heaters by one of the following:
 - 1. Dunham Bush
 - 2. Modine
 - 3. Reznor.
 - 4. Rittling.
 - 5. RUDD.
 - 6. Sterling.
 - 7. Trane.
 - 8. Vulcan Radiator Corp.
- B. Manufacturers: Subject to compliance with requirements, provide electric cabinet unit heaters by one of the following:
 - 1. Chromalox.
 - 2. INDEECO.
 - 3. Markel Products; TPI Corporation.
 - 4. Marley Engineered Products.
 - 5. QMark; Marley Engineered Products.

2.2 DESCRIPTION

- A. General: Provide unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.

Select from options below for vertical or horizontal discharge.

- B. Assembly including casing, coil, fan, and motor in **[vertical] [and] [horizontal]** discharge configuration with adjustable discharge louvers.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Retain below for electric heat option.

- D. Comply with UL 2021.
- E. Comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

Edit below to suit projects with Seismic Requirements. Coordinate ratings and requirements with the Structural Engineer.

- C. Seismic Performance: Propeller unit heaters shall withstand the effects of earthquake motions determined according to **[ASCE/SEI 7]**.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified **[and the unit will be fully operational after the seismic event]**."

2.4 HOUSINGS

- A. Construction: Construct of minimum 20-ga. steel, phosphatized inside and out, and finished with baked enamel. Fabricate casing to enclose coil and fan blades. Stratified ceiling air shall be drawn through our corrugated edged elements around the shielded motor well and through the discharge venturi.
- B. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

- D. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

- A. General Coil Requirements: Test and rate [**hot-water**] [**steam**] [**electric**] propeller unit-heater coils according to ASHRAE 33.
- B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.
- C. Steam Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 75 psig.
- D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
 2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.6 FAN AND MOTOR

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated, [**explosion proof**] [**multispeed**]. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.7 ACCESSORIES

- A. Provide with the following accessories:

Select from the options below. Four way adjustable louver is typical for horizontal units. Three cone diffuser is available for vertical units.

1. Disconnect Switch: Provide factory-mounted and wired disconnect switch.
2. Furnish fan guards.
3. Four way adjustable louver.
4. Three-cone diffuser

2.8 EXAMINATION

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.9 INSTALLATION

- A. Install propeller unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.

Select from the options below.

- C. Equipment Mounting:
 - 1. Suspend propeller unit heaters from structure with all-thread hanger rods and **[elastomeric hangers]** **[spring hangers]** **[spring hangers with vertical-limit stop]**. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in **[Section 230548 "Vibration and Seismic Controls for HVAC."]** **[Section 230548.13 "Vibration Controls for HVAC."]**
- D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

2.10 CONNECTIONS

- A. Piping installation requirements are specified in [Section 232113 "Hydronic Piping,"](#) [Section 232116 Hydronic Piping Specialties,"](#) [Section 232213 "Steam and Condensate Heating Piping,"](#) and [Section 232216 Steam and Condensate Piping Specialties."](#) Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Comply with safety requirements in UL 1995.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.2 ADJUSTING

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 238239.16

KSU DESIGNERS NOTES:

- 1. EC Motors are not currently available on prop heaters.
- 2. Coordinate thermostat and wiring to be by the TCC. Integral valve packages from manufacturer not an option.
- 3. Review control seq. of operation with JCI and OUA.

SECTION 238239.19 - WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include details of anchorages and attachments to structure and to supported equipment.
 - 4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Berko; Marley Engineered Products.
2. Chromalox, Inc.
3. INDEECO.
4. Markel Products; TPI Corporation.
5. Marley Engineered Products.
6. QMark; Marley Engineered Products.

2.2 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

- A. Front Panel: **Stamped-steel louver** **[Extruded-aluminum bar grille]**, with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's **[standard]** **[custom]** color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. **[Provide integral circuit breaker for overcurrent protection.]**

2.5 FAN AND MOTOR

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated **[, multispeed]**. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

Select from the two options below for thermostat options.

- A. Controls: Unit-mounted thermostat [**with tamper resistant cover**].
- B. Controls: Remote-mounted thermostat with low-voltage relay with transformer kit.
- C. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.7 CAPACITIES AND CHARACTERISTICS

- A. See schedules on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall and ceiling unit heaters to comply with NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 238239.19

No master specification section is provided for Temperature Controls. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 250000 – INTEGRATED AUTOMATION (TEMPERATURE CONTROLS)

PART 1 - GENERAL

PART 2 - PRODUCTS

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Johnson Controls, Inc. shall be basis of design.
- C. Outside air dampers shall be low leakage type and have a maximum air leakage of 2% of the air quantity calculated at 2,000 FPM face velocity through the damper and 4.0 inches W.G. pressure differential.
 - 1. If the installation is questionable, the contractor shall be required to test the leakage rate of the damper to verify specified maximums.
- D. Steam control valves shall be installed with actuator/shaft one bolt pattern off top dead center to minimize controller heat damage. Steam control valves are to be selected for proper steam pressure and seat material type shall be coordinated and approved by OUA. All steam control valve installation will be provided with manual (automatic optional with OUA Approval) isolation valve upstream of any installation regardless of steam pressure or application.

KSU DESIGNERS NOTES:

- 1. Review system layout with OUA and JCI prior to system selection and design.**
- 2. JCI shall be designated as a separate Prime Contractor in the contract documents in some cases, review with OUA.**

3. Designs for OA dampers shall accommodate service to the outside air intake louver and screen so cleaning of screen can be done without going through the OA damper assembly. Review layouts and access with OUA.
4. Three-way valves when used shall not be designed with a reduced port when used in a by-pass mode of operation. All control valves CV values shall be reviewed with OUA engineers.
5. Division 25-Integrated Automation guide specifications will be sent to the A/E for editing and coordination with the local JCI representative assigned to Kent State University.
6. CO2 sensors shall only be used in individual building spaces for code or LEED compliance. This is typically for rooms categorized for occupancy density of greater than 25 people per 1,000 square feet. This is meant to reduce the number of sensors that need to be replaced or calibrated.
 - a. Utilize JCI CO2 wall sensors for individual building room spaces. These sensors cannot be calibrated but are the most cost effective solution and provide a reasonable level of reliability and accuracy. If the room CO2 sensor is not used to control building or room airflow, the BAS point shall not be alarmed, and a description note in the BAS must be added indicating "Reference only – no control." Room CO2 sensors will be replaced ONLY if used to control IAQ in the BAS, when reporting unreliable through the BAS. Do NOT use combination Temperature/CO2 sensors.
 - b. Central HVAC system, duct mounted and outdoor CO2 sensors MUST be "VERIS" Brand "Deluxe" quality with LCD display to allow calibration, but must also be self-calibrating, commonly known as "Automatic Baseline Calibration (ABC)", other proven self-calibrating technologies are acceptable. VERIS CO2 sensor settings must be confirmed to enable the Self-Calibration feature. Sensors must have a minimum 5-year warranty. KELE sensors are NOT acceptable.

END OF SECTION 250000

No master specification section is provided for Integrated Automation Control Sequences. Engineer to incorporate the following relevant items from the outline below into their own specification section. Engineer to incorporate KSU's Designer Notes into the project as applicable.

SECTION 259000 - INTEGRATED AUTOMATION CONTROL SEQUENCES

PART 1 - GENERAL

PART 2 - PRODUCTS

PART 3 - EXECUTION

PART 4 - SUPPLEMENTAL REQUIREMENTS

4.1 KENT STATE UNIVERSITY SUPPLEMENTAL REQUIREMENTS:

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following notes shall take precedence in case of conflicting information listed elsewhere in document.
- B. Johnson Controls, Inc. shall be basis of design.

KSU DESIGNERS NOTES:

- 1. Most control sequences of operation have been developed by KSU OUA and JCI. This information will be given to the A/E for their project use.**

END OF SECTION 259000

MASTER SPECIFICATIONS
Kent State University

DIVISION 26 – ELECTRICAL

260500	COMMON WORK RESULTS FOR ELECTRICAL
260501	BASIC ELECTRICAL MATERIALS AND METHODS
260513	MEDIUM-VOLTAGE CABLES
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
260543	UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
260544	SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS
260573.13	SHORT-CIRCUIT STUDIES
260573.16	COORDINATION STUDIES
260573.19	ARC-FLASH HAZARD ANALYSIS
260923	LIGHTING CONTROL DEVICES
260936	MODULAR DIMMING CONTROLS
261216	DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS
261219	PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
262213	LOW-VOLTAGE DISTRIBUTION TRANSFORMERS
262416	PANELBOARDS
262726	WIRING DEVICES
262813	FUSES
262816	ENCLOSED SWITCHES AND CIRCUIT BREAKERS
262913	MANUAL AND MAGNETIC MOTOR CONTROLLERS
264113	LIGHTNING PROTECTION FOR STRUCTURES
264313	SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS
265119	LED INTERIOR LIGHTING
265213	EMERGENCY AND EXIT LIGHTING
265613	LIGHTING POLES AND STANDARDS
265619	LED EXTERIOR LIGHTING

DIVISION 27 - COMMUNICATIONS

270526	GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS
270528	PATHWAYS FOR COMMUNICATIONS SYSTEMS
270529	HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS
270536	CABLE TRAYS FOR COMMUNICATIONS SYSTEMS
270543	UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS
270544	SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING
270553	IDENTIFICATION FOR COMMUNICATIONS SYSTEMS
271100	COMMUNICATIONS EQUIPMENT ROOM FITTINGS
271116	COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES
271313	COMMUNICATIONS COPPER BACKBONE CABLING
271323	COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING
271333	COMMUNICATIONS COAXIAL BACKBONE CABLING
271513	COMMUNICATIONS COPPER HORIZONTAL CABLING
271533	COMMUNICATIONS COAXIAL HORIZONTAL CABLING

END OF TABLE OF CONTENTS

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL REFERENCE AND GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Division 01 section "Alternates" for possible alternates affecting the extent of this section of work.
- C. This Contractor is also referred to the Architectural, Structural, Mechanical and all other drawings and specification pertinent to this project. All of the above mentioned drawings and specifications are considered a part of the Contract Documents.
- D. This section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in sections of Division 01.

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:
 - 1. Description of work.
 - 2. Shop drawings
 - 3. Definitions
 - 4. Discrepancies
 - 5. Record drawings.
 - 6. Equipment
 - 7. Substitutions
 - 8. Codes and permits.
 - 9. Interferences
 - 10. Delivery, storage and handling.
 - 11. Operating and maintenance.
 - 12. Punchlists
 - 13. Warranties

1.3 DESCRIPTION OF WORK

- A. Extent of electrical related work required by this section is indicated on drawings and/or specified in other Division 26 sections.
- B. Except as noted in this specification, this Contractor shall be all excavating and backfilling necessary to the work of this Division.

- C. This Contractor is to coordinate all excavating and backfilling required under this Division with work specified under Division 02.
- D. See specification Division 09 for painting requirements. Coordinate all electrical painting work required. Coordinate protection requirements for electrical equipment which could be damaged by painting.
- E. Furnish and install all miscellaneous steel required for supports, hangers, anchors, etc., required for installation of equipment and materials furnished and installed under this Division. Steel used in a damp or wet environment shall be hot dipped galvanized unless otherwise noted.
- F. Furnish and install all miscellaneous lumber required for support of electrical equipment, telephone backboards, etc.
- G. This Contractor shall furnish and install concrete foundations or bases under all electrical equipment that rests on floors, concrete encased ductbanks and exterior lighting fixture pole bases. He shall follow drawings and/or manufacturer's literature with regard to design and construction of same.
- H. This Contractor shall provide to the General Contractor, dimensions and special requirements for the concrete foundations or bases under all electrical equipment that rests on floors, concrete encased ductbanks and exterior lighting fixture pole bases. He shall follow drawings and/or manufacturer's literature with regard to design and construction of same.
- I. Furnish and install fire stopping for sealing around electrical penetrations through fire or smoke barriers, and floors.
- J. This Contractor shall perform all Division 26 related and indicated demolition including: Nondestructive removal of materials and equipment for re-use or salvage as indicated. All equipment removed shall be offered to the Owner for his retention. If the Owner elects to retain equipment, it shall be turned over to the Owner at the site. If not, the equipment shall be removed from the premises by this Contractor. Refer to Division 02 Section "Selective Demolition" for additional requirements.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including the recommended installation method, all in accordance with Division 01 and Section 26 requirements.
- B. Electrical Penetration Seals: Submit the following:
 - 1. Manufacturer's specifications, recommendations, installation instructions and maintenance instructions.

1.5 DEFINITIONS

- A. To achieve brevity in Specification and on Drawings, certain words and phrases not contributing to clarity have been omitted. Unless mentioned specifically as work to be done by Other Trades, all requirements contained in the Specifications and shown on the Drawings shall be

performed by the Principal Contractor for this Division of the Contract. The following definitions shall apply:

1. Where the work “provide” is used in connection with a system, equipment, or time, it shall be construed to mean the furnishing and installing of the system, equipment or item.
 2. Where the phrases “as directed” is used it shall be construed to mean as directed by the Kent State Project Manager or their authorized representative.
- B. The term “Contractor” as applied to work specified, shown or reasonably implied in the contract documents for Division 26 shall be defined as the subcontractor who is responsible for the work specified or indicated. All subcontracted work must be incorporated by and coordinated by the Prime Contractor.
- C. The term “Contractor” as applied to work specified, shown or reasonable implied in the contract documents for Division 26 shall be defined as the prime contractor who is responsible for the work specified, or indicated. All work subcontracted to each prime contractor must be incorporated by the coordinated by each prime contractor.

1.6 DISCREPANCIES

- A. Should it appear that there is a discrepancy between or within the drawings and/or specifications concerning the nature, quality or extent of materials or work to be furnished and/or installed, and such discrepancy is not clarified by Addendum during the bidding period, this Contractor shall base his bid on performing the work in the manner having the higher cost. The Kent State Project Manager shall have the option of selecting either of the manners shown and/or specified. In the event the lower cost manner is selected, a credit shall be due the Owner in the amount of the difference between the lower cost and higher cost manner. All discrepancies shall be called to the attention of the Kent State Project Manager before proceeding with wor affected thereby.
- B. Should it appear that there is a duplication on the Drawings or in the Specifications, wherein the same work or items are shown or specified as being provided under different contracts, subcontracts or supply orders, and such duplication is not clarified by Addendum during the bidding period, it shall be assumed that the prime contractors have included duplicate quotations in their proposal to the Owner. The Kent State Project Manager shall have the option of selecting the contract, subcontract or supply order under which the work or items are to be provided and a credit shall be due the Owner for the duplicate work or items.
- C. Where a discrepancy exists within the specifications, among the drawings, or between the specifications and the drawings, refer to project supplementary conditions.
- D. The design drawings, as submitted, are diagrammatic and are not intended to show exact location of equipment, electrical devices, etc. unless dimensions are given. Drawings are not to be scaled.
1. Equipment shall be installed along the general arrangement indicated on the drawings, and in accordance with the manufacturer’s instruction.
 - a. Provide at least the minimum manufacturer’s recommended and code required clearance around the equipment for normal maintenance.

- b. Locate and arrange equipment in relationship to other system components to assure that the equipment will be operating under the best possible conditions to meet the scheduled performance requirements.
- 2. Raceways are to be installed along the general plans shown on the drawings keeping in mind the constraints of the available space and the need to coordinate with the work of other trades. Additional bends, pull and splice boxes shall be provided as necessary to meet space constraints and to facilitate the work of other trades.
- E. Electrical equipment, specified hereinafter or as shown on the drawings shall be furnished and installed by this Contractor, unless specifically indicated to the contrary.
- F. Occasionally, certain references may be indicated on the drawings to items which are suggested to be furnished and/or installed by various subcontractors. This is done to assist the applicable Prime Contractor in organizing his subcontractor's bids. However, no attempt has been made, nor is it implied, that this specification or plans are attempting to specifically divide all responsibilities for subcontractors. It is the Prime Contractor's responsibility that all items covered on electrical plans and Division 26 specifications are included in his bid and are coordinated with his subcontractors. No consideration will be given for Prime Contractor's failure to include all applicable electrical work in his bid.
- G. Where more than one manufacturer is named for major items of equipment, the manufacture noted on the Drawings has been used as a basis for design. If another manufacturer is used, other than the one named on the Drawings, it shall be the responsibility of this contractor to ensure that the equipment will fit the space with all legal clearances, or bear the expense to change the space and structure to accommodate equipment used.

1.7 RECORD DRAWINGS

- A. Prepare record documents in accordance with the requirements of this division, and in Division 01.
- B. This Contractor shall record all changes from original design drawings which were made during the installation of the work. These changes shall be recorded in red ink on a designated set of prints. Changes shall be accurately dimensioned and/or drawing to scale.
- C. This Contractor shall keep an updated set of specifications and prints, including changes on the job site, at all times and shall submit one (1) set of updated and legible prints to the Kent State Project Manager when the work is complete.

1.8 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of electrical service and/or power with the Owner and the utility company. All associated work to be done at Owner's convenience.
- B. Notify the Engineer at least 5 working days prior to commencing demolition operations.
- C. Perform demolition in phases as required by Engineer.

1.9 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- E. Unless otherwise additionally required in "Project Coordination" sections, prepare and submit for approval coordination drawings drawn to readable scale of all areas where equipment or materials are being used which are not basis of specification and result in a change in the accessibility, performance, or serviceability of such equipment, or a conflict with other trades. Such equipment or materials shall not be installed until it receives approval from the Kent State Project Manager

1.10 EQUIPMENT

- A. Before entering into a contract, the successful bidder may be required to submit satisfactory evidence to show that an equipment manufacturer has been regularly engaged in the manufacture of such equipment for three (3) years and have not less than three (3) installations of a similar type which have been in successful operation under conditions similar to those specified for not less than two (2) years.
- B. When two or more items of same equipment are required (panelboards, switchboards, transformers, etc.) they shall be of the same manufacturer.

1.11 SUBSTITUTIONS

- A. Refer to the Instructions to Bidders and the related Division 01 sections for requirements in selecting products and requesting substitutions.
- B. Bids concerning the use of substitute products must be accompanied by complete specifications and performance characteristics covering these products, together with such available test data and experience records as may be helpful to the Engineer in evaluating the quality and/or suitability of the proposed products.

- C. When more than one make or name is mentioned as being acceptable, it shall be understood that only the name or make referring to the manufacturer's model numbers or sizes shall be considered the "Specified Standard". It shall be further understood that other makes and names, even though mentioned, have not been checked for detail and that their size and arrangement are the Contractor's responsibility the same as a proposed substitute item.
- D. The intent of this paragraph is to make the specifications open to all available makes of material and apparatus during the bidding period. Certain definite makes or kinds of items are specified as "standards of quality" and character required. This Contractor is required to bid upon the basis of furnishing the makes specified. He is also invited to bid on any other similar makes he (the Contractor) may desire to propose as substitutions, stating any difference in cost (if any) for each proposed substitution on either the Proposal or the Voluntary Substitution Sheets. If the Engineer shall decide to accept any of the proposed substitutions, proper notations thereof shall be made in the written contract. Where several makes are mentioned in the specifications and the Contractor fails to state that he prefers a particular make in his bid, the Owner shall have the right to choose any of the makes mentioned without change in price. No consideration will be given to proposals for alternative products unless submitted with the original bids.

1.12 CODE AND PERMITS

- A. All equipment, materials and installation shall comply with the National Fire Protection Association's "National Fire Codes" and "National Electrical Code". Equipment shall bear the "UL" label as required by these codes.
- B. Install work in full accordance with rules and regulations of State, County and City authorities having jurisdiction over premises. This shall include safety requirements of Ohio State Department of Industrial Relations. Do not construe this as relieving Contractor from compliance with any requirements of specification which are in excess of Code requirements and not in conflict therewith.
- C. Unless otherwise indicated, secure and pay for all permits and certificates of inspection incidental to this work required by foregoing authorities. Be responsible for payments to all public utilities for temporary service work performed by them in connection with provision of temporary service required under this Division of specifications. Deliver all certificated to Kent State Project Manager in duplicate.

1.13 INTERFERENCES

- A. Before installing any work, this Contractor shall see that it does not interfere with clearance required for finish on beams, columns, pilasters, walls or other structural or architectural members, as shown on Architectural Drawings. If any work is so installed and it later develops that Architectural design cannot be followed, Contractor shall, at his own expense, make such changes in his work as the Kent State Project Manager may direct to permit completion of Architectural work in accordance with plans and specifications.
- B. Install additional conduit, pullboxes, spliceboxes, etc. where required to obtain maximum headroom or to avoid conflict with other work without additional cost to the Owner. Where mounting heights are not detailed or dimensioned, install electrical conduit and overhead equipment to provide the maximum headroom possible.

- C. Report any interferences between work under this division and that of any other Contractor to the Kent State Project Manager as soon as they are discovered. The Kent State Project Manager will determine which equipment shall be relocated, regardless of which was first installed, and his decision shall be final.

1.14 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall make provisions for the delivery and safe storage of his materials and equipment in coordination with the work of others. Materials and equipment shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected. The arrival and placing of large equipment items shall be scheduled early enough to permit entry and setting when there is no restriction or problem due to size and weight.
- B. Kent State will not except delivers for contractors.

1.15 PUNCHLISTS

- A. From time to time throughout the course of the work, or upon completion of the work the Design Professional may perform site observations resulting in written documentation of deviations in the work from the Contract Documents. In such cases the Contractor shall respond in writing to each and every item on this written documentation stating the specific action taken to remedy the deviation. A response shall be provided by the Contractor for each separate observation. This work shall not be considered complete until such satisfactory written response is received by the Design Professional. Contractor shall submit the responses to these items as part of the closeout documentation.

1.16 OPERATING AND MAINTENANCE

- A. This Contractor shall furnish competent personal instruction to the Owner's operating personnel for a period of hours as indicated in individual Division 26 specification sections in the proper operation of the electrical equipment. He shall also supply the Owner with one (1) hardbound copy and (1) electronic copy of an operation manual containing the following:
 - 1. Step-by-step procedures for start-up and operation for each system and piece of equipment.
 - 2. Performance data, curves, ratings.
 - 3. Wiring diagrams.
 - 4. Manufacturer's descriptive literature.
 - 5. Manufacturer's maintenance and service manuals.
 - 6. Spare parts and replacement parts list for each piece of equipment.
 - 7. Name of service agency and installer complete with an emergency service phone number for nights, weekends and holidays.
 - 8. Final approved shop drawings.

1.17 WARRANTIES

- A. Refer to Division 01 Section: Specific Warranties for procedures and submittal requirements for warranties. Refer to individual equipment specifications for additional warranty requirements.
- B. This Contractor shall warranty all materials, workmanship and the successful operation of all equipment and apparatus installed by him for a period of one year from the date of the final acceptance of the entire work and shall guarantee to repair or replace at his own expense any part of the apparatus which may show defect during that time provided such defect is, in the opinion of the Kent State Project Manager, due to imperfect material or workmanship and not to carelessness or improper use. Compile and assemble the warranties specified in Division 26 into a separated set of vinyl covered three-ring binders, tabulated and indexed for easy reference.

PART 2 - PRODUCTS

2.1 EXCAVATING FOR ELECTRICAL WORK:

- A. Backfill Materials:
 - 1. All backfilling within the building shall consist of a 6" layer of sand under the conduit and a 12" layer of sand over the conduit. The remainder of the backfill shall be coarse interlocking aggregate.
 - 2. All backfilling outside the building shall be selected dirt, free of large stones.

2.2 MISCELLANEOUS METALS:

- A. Fasteners: Zinc-coated, type, grade, and class as required.
- B. Metal Framing: As manufactured by Unistrut or Kindorf unless noted otherwise. Provide framing of sizes required by specific application.

2.3 MISCELLANEOUS LUMBER:

- A. Electrical backboards to be 5/8" thick ACX-EXT, Non-Com plywood. Paint both sides and all edges with grey fire-retardant paint.

2.4 MATERIALS OF CONCRETE WORK:

- A. Reinforcing Materials:
 - 1. Reinforcing Bars: Except as otherwise indicated, provide ASTM A 615, deformed, Grade 40 for size numbers 3 through 18; ASTM A 675, plain, Grade 60, for size number 2; sizes as indicated or required.

- B. Reinforcement Supports: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Provide wire bar type supports complying with CRSI recommendations, unless otherwise indicated.
- C. Concrete Materials:
 - 1. Portland Cement: ASTM C 150, Type I, except as otherwise indicated.
 - 2. Aggregates: ASTM C 33, except as otherwise indicated.
 - a. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used.
 - b. For rough grouting, provide aggregate which is well graded and 100 percent passing through 3/8" sieve.
 - 3. Water: Clean and free of substances harmful to concrete.

2.5 DESIGN AND PROPORTIONING OF CONCRETE MIXES:

- A. General: Design electrical work concrete as follows, for each 28-day compressive strength class:
 - 1. 4000 psi Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.35 water/cement ratio.
 - 2. 3000 psi Class: 500 lbs of cement per cu. yd. (5.25 sacks), and 0.46 water/cement ratio.
 - 3. 2500 psi Class: 450 lbs. of cement per cu. yd. (4.75 sacks), and 0.54 water/cement ratio.
 - 4. Rough Grouting Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.60 water/cement ratio.
- B. Mix for Patching: Where electrical work requires patching of exposed concrete work which has been cut to accommodate electrical work, provide concrete patching mix which is identical with mix of work being patched (same cement, aggregates, admixtures and proportioning).

2.6 FIRE STOPPING MATERIALS:

- A. Fire stopping materials shall be intumescent safety barriers designed to block the spread of fire and smoke through penetrations created by electrical installations in fire rated walls and floors. Materials shall be flame, toxic fume and water resistant and shall have a minimum 3 hour fire rating. Fire rating shall be defined by tests conducted by ASTM, UL or other testing and inspection agencies acceptable to authorities having jurisdiction.
- B. The fire stopping materials used on the entire project shall be selected and submitted by the general contractor. The electrical contractor and all other trades are to coordinate with the general contractor and provide the same manufacturer and type of materials. The following manufacturers and materials listed below are for reference only.

1. Acceptable Manufacturers:

Specified Technologies, Inc. (STI) Somerville, NJ
Tremco, Inc. Beachwood, OH
3M Inc., Minneapolis, MN

2. Materials:

- a. Firestop Mortar:
STI SpecSeal Mortar
Tremco TREMstop-M
3M Fire Barrier Mortar
- b. Intumescent Firestop Sealants and Caulks
SpecSeal SSP Putty
Tremco TREMstop-WBM
3M Fire Barrier CP-25 WB
- c. Silicone Firestop Sealants Caulks
STI SpecSeal Pensil 100 & 300
Tremco Fyre Sil Sealant
3M Fire Barrier 2000 & 2003
- d. Firestop Putty:
STI SpecSeal Firestop Putty Bars & Pads
Tremco TREMstop FP Flowable Putty
3M Fire Barrier Firestop Putty
- e. Firestop Collars:
STI SpecSeal Firstop Collars
Tremco TREMstop D Combustible Pipe Device
3M Fire Barrier Pipe Device
- f. Wrap Strip:
STI Spec Seal Wrap Strip
Tremco TREMstop-WS
3M Fire Barrier WS-195 Wrap Strip

- C. Sleeves shall be Schedule 40, galvanized steel with plain end. Sleeves shall be no more than two sizes larger than single penetrating conduit. For multiple cable or conduit penetrations, make sleeve as small as possible to allow for penetrating items and firestopping material.

2.7 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 EXAMINATION AND PROJECT CONDITIONS

- A. Examine area and conditions under which basic electric materials are to be installed or methods are to be performed and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.
- B. Conditions Affecting Demolition: The following conditions apply.
 - 1. Protect adjacent materials to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- C. Conditions Affecting Excavations: The following project conditions apply:
 - 1. Maintain and protect existing building services which transit the area affected by excavation.
 - 2. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlements, lateral movement, undermining, washout, and other hazards created by excavation operations.
 - 3. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
- D. Notify proper authorities prior to commencing excavation. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
- E. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
 - 1. Provide minimum of 14 working days notice to Engineer, and receive written notice to proceed before interrupting any utility.
- F. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.
- G. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights. Where trenches cross roads, walks, or public thoroughfares, provide suitable barricades and bridges or plating adequately protected by signs or red flags during day and lights at night.
- H. Operate warning lights as recommended by authorities having jurisdiction.

- I. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

3.2 EXCAVATION AND BACKFILLING

- A. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.
- B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- C. Install sediment and erosion control measures in accordance with local codes and ordinances.
- D. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- E. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- F. Excavation for Underground Vaults and Electrical Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
 - 1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 - 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- G. Trenching: Excavate trenches for electrical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
 2. Excavate trenches to depth as required.
 3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel to 6" below conduit.
- H. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 deg F (1 deg C).
- I. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a course interlocking aggregate ODOT #6, 67, 68, 7, 78 or 8 equivalent.
 2. Under building slabs, use a course interlocking aggregate ODOT #6, 67, 68, 7, 78 or 8 or equivalent.
 3. Under conduit and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For raceways less than 30 inches below surface of roadways, provide 4-inch thick concrete base slab support. After installation of raceways, provide a 4-inch thick concrete encasement (side and top) prior to backfilling and placement of roadway subbase.
 5. Other areas, use excavated or borrowed materials, free of large stones.
 6. Consult drawing details and local municipality requirements not on KSU property
- J. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- K. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches of loose depth for material compacted by hand operated tampers.
- L. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen or contain frost or ice.
- M. Place backfill and fill materials evenly adjacent to structures, conduit and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- N. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Other Than Under Building or Pavement: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- O. Subsidence: Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality and condition of surface or finish to match adjacent areas.

3.3 DISPOSAL OF EXCESS AND WASTE EXCAVATION MATERIALS

- A. Removal from Owner's Property: Remove excess excavated material, trash, debris and waste materials and dispose of it off Owner's property.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code".

3.5 MISCELLANEOUS LUMBER

- A. Cut, fit and place miscellaneous lumber fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Both sides and all edges of all lumber fabrications shall be painted with two (2) coats of grey fire-retardant paint unless noted otherwise.

3.6 INSTALLATION OF CONCRETE WORK

- A. Formwork:
1. General: Design, construct and maintain formwork to support vertical and lateral loads including pressure of cast-in-place concrete. Construct formwork so that formed concrete will be of required size and shape and in required location. Construct with joints which

will not leak cement paste. Form sides and bottom of concrete work, except where clearly indicated to be cast directly in excavation or against other construction, or on grade or prepared subgrade. Design and construct forms for easy removal without damage to concrete and other work.

- a. Install chamfer strips at external corners of exposed concrete work.
- b. Construct forms to retain equipment anchor bolts in accurate locations during placement of reinforcing steel and concrete. Use templates furnished by equipment manufacturers to locate anchor bolts or where not furnished, located by accurate measure from certified setting diagrams.

B. Placing Reinforcement:

1. General: Comply with requirements and recommendations of specified standards, including "Placing Reinforcing Bars" by CRSI. Place bars where indicated and support to prevent displacement during concrete placement, using appropriate reinforcement supports, properly spaced and wire tied to reinforcing bars.
 - a. Place reinforcement to obtain at least minimum recommended coverages for concrete protection. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which would reduce bond with concrete.

C. Placing Concrete:

1. Wet wooden forms which have been coated with compound, immediately before concrete, and remove excess water from forms.
2. Strength-Class Application: Comply with the following general application requirements.
 - a. Plain Concrete Encased Ductbanks: Provide 2500 PSI class.
 - b. Reinforced Concrete Encased Ductbanks: Provide 3000 PSI class.
 - c. Underground Structural Concrete: Provide 3000 PSI class.
 - d. Concrete Pole Bases: Provide 4000 PSI class.
 - e. Miscellaneous Supported Work: Provide 3000 PSI class for electrical equipment pads and similar supported work.
 - f. Concrete Fill: Provide 2500 PSI class for filling structural steel foundation frames and for filling similar large-volume units.
 - g. Concrete Grout: Provide rough grouting class for filling voids to be grouted which are too small to be filled effectively with 2500 PSI class concrete.
 - h. Patching General Concrete Work: Match concrete being patched.
3. Deposit concrete continuously or in layers of thickness which will result in no concrete being placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within section. If section cannot be placed continuously, provide construction joints. Deposit concrete as nearly as practicable in its final location, so as to avoid segregation due to rehandling or flowing.

4. Consolidate placed concrete by mechanical vibrating equipment supplement by hand-spading, rodding or tamping. Use equipment and procedures complying with recommended practices of ACI 309; eliminate voids in work.
5. Bring horizontal surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps and hollows.
6. Cold Weather Placement: Comply with ACI 306. Do not use frozen materials or materials containing ice and snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. When air temperature has fallen or is expected to fall below 40 deg F (4.4 deg C), heat water and aggregates uniformly before mixing, as required to obtain concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (26.7 deg C), at time of placement. Protect concrete work from physical damage and reduced strength resulting from frost, freezing actions, or low temperatures.
7. Finishing Horizontal Surfaces: Float and trowel horizontal (top) surfaces to level, smooth, uniform textured, dense finish, where surface is to remain exposed or receive coating, membrane or other thin-set finish. Otherwise leave stuck-off surface undisturbed; except scratch surfaces which are to receive concrete or mortar topping.
8. Finishing Concrete Pole Bases: Remove all exposed formwork. "Sonotube" forms shall be removed to below depth of adjacent paving or grade whichever is applicable. Rub out entire surface of concrete pole base to smooth, uniform texture.
9. Surface Repairs:
 - a. Unexposed Surfaces: Repair significantly damaged and honeycombed areas, and remove major projections and fins where forms have been removed.
 - b. Exposed Surfaces: On formed surfaces which are to be exposed, including those to be coated or covered with membrane or other thin-set applied finish, repair and patch form-tie holes and damaged and honeycombed areas, filling voids with grout and completely removing fins and other projections.

3.7 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from drying and excessively cold and hot temperatures, and maintain in moist condition at relatively constant temperature for period of time necessary for hydration of cement, proper hardening, and achievement of strength requirements as specified.

3.8 MISCELLANEOUS CONCRETE WORK

- A. Concrete Grouting: Space approximately 1" thick between bottom of equipment and top of concrete foundation or base which remains after shimming, shall be filled completely with grouting. Grout shall be made up with sand and cement designed for the purpose which does not shrink on setting up. Exposed surface of grouting shall be finished to make a neat appearance. Grout openings and recesses as indicated, in and around mechanical work and other work which penetrates or adjoins mechanical concrete work, using rough grouting class of concrete mix. Provide formwork where required, and tamp, screed and trowel surfaces. Cure grout as specified for concrete work.

- B. Concrete Bases: In the absence of more specific information, either on drawings, or manufacturer's literature, the bases shall be level, shall have a minimum height above finished floor of 3-1/2" and extend 3" beyond the base dimensions of the item of equipment.
- C. Concrete pads placed in existing structures shall be mounted securely to the original substrate with anchor bolts.

3.9 ROUGH-IN

- A. Verify with Kent State Project Manager prior to rough-in, exact location of items such as switches, receptacles, clocks, speakers, fire alarm devices, floor boxes, surface-mounted raceways, etc., in finished areas.
- B. Verify with respective equipment supplier prior to rough-in, exact location and method of connection to respective equipment for such items as mechanical equipment, etc.

3.10 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 7. Coordinate connection of electrical systems with exterior underground and/or overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 - 9. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components.
 - 10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

11. Provide access panel or doors where units are concealed behind finished surfaces such as drywall and/or plaster construction, etc. Coordinate the access panel type with the Kent State Project Manager
12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope (such as for underground services, etc.).
13. All wiring other than within an item of equipment, to be in raceways unless shown otherwise on Drawings or covered otherwise in these Specifications.
14. Raceways, boxes, cables, conductors, etc., installed in plenum spaces and similar areas shall be supported from the building structure and shall be installed symmetrical with the axis of the space (do not cross room at an angle). Support wires for lay-in type grid ceilings shall not be used to support electrical equipment, raceways, cables, etc. Use J-hooks rated to support communication cables.
15. Wiring of Motors and/or Equipment:
 - a. Provide necessary power wiring to motors and/or equipment where shown on Drawings.
 - 1) Make final "line" connections to respective items of equipment as shown on drawings.
 - 2) Provide "Control" wiring, regardless of voltage, only when shown on Electrical Drawings.
 - 3) In general, all 120, 208, 240, 277 or 480 volt wiring to be construed as power wiring; however, line voltage control wiring shall not be construed as power wiring unless shown on Electrical Drawings.
16. Wiring of Heating, Ventilating, and Air Conditioning Equipment:
 - a. Provide power wiring as shown on Electrical Drawings. In general, this shall consist of power conductors and raceway up to and including connections to line terminals of respective items or equipment.
 - 1) Where this Contractor furnishes motor starter and/or disconnect switch, this also shall include the power wiring between the load side of starter and/or disconnect switch and line terminals of respective item of equipment.
 - 2) Where other Divisions furnish motor starter and/or disconnect switch (other than factory-mounted, prewired items), this contractor shall provide power wiring as described in previous paragraph and shall mount respective starter and/or disconnect switch.
 - 3) Where electric heating equipment is involved, wiring responsibilities to be as shown on Electrical Drawings.
 - 4) Control wiring, regardless of voltage characteristics, is not to be construed as power wiring and is not the responsibility of this Contractor unless indicated as such on Electrical Drawings.

In certain cases, such as between a thermostat and a cabinet heater or a unit heater, or between a switch and a small exhaust fan, wiring may be required by this Contractor only if shown on Electrical Drawings.
 - 5) It shall be the responsibility of this Contractor, prior to rough-in of conduits serving mechanical equipment, to verify with respective equipment supplier the required ampacity and quantity of conductors serving the equipment. In the event changes are required from those shown on the drawings, this information shall be brought to the attention of the Engineer and authorization obtained from the Engineer in writing prior to proceeding with

the necessary changes. Changes required shall be performed at the expense of the mechanical (HVAC or plumbing) contractor.

17. Wiring of Plumbing Equipment:

- a. Provide necessary power wiring to plumbing equipment requiring same, where shown on Electrical Drawings.
- b. Control equipment such as thermostats, pressure switches, etc., to be furnished, set in place, and wired by other Divisions, unless shown otherwise on Electrical Drawings.
- c. Provide necessary disconnect switches, starters, or contactors where shown on Electrical Drawings.

18. Wiring of Kitchen Equipment:

- a. Provide necessary conduit, wire, disconnect switches, and connections to all kitchen equipment, where shown on Drawings.
 - 1) Provide power wiring between disconnect switch and respective piece of kitchen equipment; however, control wiring to be responsibility of others unless shown otherwise on Drawings.
 - 2) It shall be the responsibility of this Contractor to obtain the exact location of all junction boxes, outlets, conduit stubs, etc., from kitchen equipment supplier before installation of same. (NOTE: Locations shown on Drawings are only approximate and may vary with different equipment.)
 - 3) Use "Sealtite" conduit and fittings for final connections to dishwashers, booster heaters, disposals, and other motor driven equipment.
 - 4) Disconnect switches under counters to have NEMA 3R enclosures.

19. Temperature Control Wiring:

- a. Temperature control wiring, regardless of voltage characteristics, is not the responsibility of this Contractor unless indicated as such on Electrical Drawings or herein described.
 - 1) In general, the furnishing and installing of all temperature control devices and respective wiring shall be the responsibility of other Divisions.

20. Wiring of Motor Operated or Automatic Doors:

- a. All control devices, such as pushbuttons, limit switches, etc., shall be furnished by other Divisions, and installed and wired by this contractor, unless shown otherwise on the Electrical Drawings.
- b. Power wiring up to and including connection to the overhead door motor system main control pane or junction box, and to the motor from same, if not factory prewired shall be the responsibility of this Contractor.

3.11 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING". In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Demolition of electrical items required to be removed from structure to remain.
 - b. Uncover work to provide for installation of ill-timed work.
 - c. Remove and replace defective work.
 - d. Remove and replace work not conforming to requirements of the Contract Documents.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the Kent State Project Manager, uncover and restore work to provide for Kent State Project Manager, observation of concealed work.
2. Cut, remove, and legally dispose of electrical equipment, components, and materials, including but not limited to electrical items to be removed and items made obsolete by the new work.
3. Protect the structure, furnishings, finishes, and adjacent materials not to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
6. Patch new and/or existing finished surfaces and building components using new materials matching existing materials and using workmen skilled in respective trade.
7. Where existing construction such as floors, walls, ceilings, etc., must be cut to relocate, remove or add raceways and/or equipment, such construction to be restored to original condition to satisfaction of Kent State Project Manager, by this Contractor using workmen skilled in respective trade.
8. General penetrations through walls, floors, slab, etc. will be patched with materials to match the surrounding surface (i.e. vinyl concrete patch for concrete surfaces, joint and patching compound for drywall surfaces, etc.). If the penetrated surface is a fire or smoke barrier, refer to "Installation of Fire Stopping Materials" in this section.

3.12 INSTALLATION OF FIRE STOPPING MATERIAL

A. General:

1. All fire and smoke rated walls and floors penetrated by electrical raceways, exposed conductors, etc. shall be properly sleeved and fire sealed. See Division 7 "Firestopping". All firestop system types shall be by same manufacturer to fullest extent possible.
2. All fire stopping will be installed in accordance to the U.L. rated system designed for the application.
3. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
4. Grout, mortar or gypsum products shall not be installed in lieu of firestopping material specified here.

B. Sleeves:

1. Wall and floor opening shall be made as small as possible. Install sleeves during the erection of concrete or masonry walls. Sleeve shall be grouted in using material to match surrounding surface. Install electrical raceway, exposed conductors, etc. through sleeve and install fire stopping, intumescent material.

C. Penetrations – Provide Firestopping:

1. Where penetrations including conduit, cable, wire, or other elements which pass through one or both outer surfaces of a fire rated floor or wall.
2. Except for floor on grade, where a penetration occurs through a structural floor or roof and a space would otherwise remain open between the surfaces of the penetration and the edge of the adjoining structural floor or roof.
3. Where a penetration occurs through fire-rated walls, or partitions of hollow-type construction, provide fire stopping to completely fill spaces around the penetration, on each side of the wall or partition.
4. These requirements for penetrations shall apply whether or not sleeves have been provided, and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved, fire stop annular space, if any, between sleeve and wall opening.

- D. Provide fire stopping to fill miscellaneous voids and blank openings in fire-rated construction where conduit, cable, wire or equipment has been removed.

3.13 SELECTIVE DEMOLITION AND ALTERATION OF EXISTING ELECTRICAL SYSTEMS

A. Demolition Definitions:

1. Under demolition notes, several words and phrases are used. These shall be interpreted to mean as follows:
 - a. Abandon: Disconnect designated equipment and remove respective conductors back to source, such as a panelboard, distribution panel, switchboard, switchgear, etc. Alter respective legend accordingly.
 - b. Disconnect: Disconnect designated equipment and remove respective branch circuit wiring and affected exposed electrical equipment, such as boxes, raceways, and control, etc.
 - 1) Remove conductors back to source such as panelboard, etc. Alter respective legend accordingly.
 - 2) Remove exposed raceway. When in unfinished areas such as mechanical equipment rooms, remove back to source. When in finished spaces, remove only that raceway which is exposed.
 - 3) Where raceway is above an existing suspended, accessible ceiling and that ceiling grid is being reused or replaced, remove the exposed raceway in the affected area. Concealed homeruns are to remain and may be reused at Contractor's option.
 - c. Disconnect and Reconnect: Disconnect designated items, remove and store same where necessary, and then reinstall item and reconnect to existing branch circuit and control.

- d. Remove Branch Circuit and/or Feeder: Remove conductor and respective raceway, fittings, boxes, etc.
- B. Where existing building construction is to be altered to accommodate the planned renovations and/or an addition(s), alter existing electrical service and distribution system, communications systems, fire alarm system etc., as shown on the drawings and as required for proper operation of the altered system.
- C. Where existing accessible ceiling grid panels and grid support members are removed to permit the installation of new conduit, boxes, etc., it shall be the responsibility of this Contractor to reinstall the panels and grid support system to the satisfaction of the Kent State Project Manager. Damaged items shall be replaced at not cost to the Owner.
- D. Remove all existing affected electrical equipment, devices, fixtures, boxes, etc. which are not incorporated into or are not necessary for the operation of new and/or existing electrical systems, making sure that no remaining fixtures, devices, or appliances are left without service.
- E. Make sure that no remaining fixtures, devices, etc. within the renovated area or adjacent areas are left without service.
 - 1. Services and/or power outages and cutovers to be coordinated. Engineer and Owner and done at Owner's convenience.
 - 2. Modify existing "systems" as required to accommodate added equipment.
 - 3. Remove abandoned accessible surface-mounted boxes and raceway. Abandoned accessible surface raceway shall be removed complete back to source.
 - 4. Where an abandoned raceway penetrates floor, slab, wall, etc. raceway shall be cut below the surface. Seal the opening and restore respective surface to match surrounding surface as directed.
 - 5. Where an abandoned raceway is not accessible, the raceway shall remain. Any accessible portions penetrating out of wall, floor, slab, etc. shall be cut off below the surface. Seal the opening and restore the respective surface to match the surrounding surfaces as directed.
 - a. Perform cutting and patching required for demolition in accordance with Division 1 and Division 2 section "Cutting and Patching".
 - 6. Flush mounted outlet boxes which are abandoned or used for junction boxes and are not concealed by new construction shall have openings covered by a blank, stainless steel plate.
 - 7. Where an existing distribution center is altered, provide a new, accurate, typed legend.
 - 8. Where work cannot be executed during normal working hours, this Contractor shall include in the Base Bid all necessary overtime pay to execute this contractors contract.
- F. All electrical equipment removed and not scheduled for reuse shall be turned over to the Owner at the construction site for salvage. All items deemed not salvageable by the Owner shall become the property of this Contractor and shall be removed from the site within 72 hours.

END OF SECTION 260500

SECTION 260501 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 26 Basic Electrical Requirements and Basic Electrical Materials and Methods section apply to work specified in this is section.

1.2 DESCRIPTION OF WORK

- A. Extent of electrical related work required by this section is indicated on drawings and/or specified in other Division 26 sections.
- B. Furnish and install all miscellaneous steel required for supports, hangers, anchors, etc., required for installation of equipment and materials furnished and installed under this Division. Steel used in a damp or wet environment shall be hot dipped galvanized unless otherwise noted.
- C. Furnish and install all miscellaneous lumber required for support of electrical equipment, telephone backboards, etc.
- D. This Contractor shall furnish and install concrete foundations or bases under all electrical equipment that rests on floors . He shall follow drawings and/or manufacturer's literature with regard to design and construction of same.
- E. Furnish and install fire stopping for sealing around electrical penetrations through fire or smoke barriers, and floors.
- F. This Contractor shall perform all selective Division 26 related and indicated demolition including: Nondestructive removal of materials and equipment for re-use or salvage as indicated. All equipment removed shall be offered to the Owner for his retention. If the Owner elects to retain equipment, it shall be turned over to the Owner at the site. If not, the equipment shall be removed from the premises by this Contractor. Refer to Division 2 Section "Selective Demolition" for additional requirements.

1.3 SUMMARY

- A. This section includes a limited scope of general construction materials and methods pertaining to Division 26 applications of the following items:
 - Excavation and backfilling

Miscellaneous Metal
Miscellaneous Lumber
Concrete work
Rough-ins
Electrical installations
Cutting and patching
Fire stopping
Selective demolition and alterations

1.4 PROJECT CONDITIONS

A. Conditions Affecting Demolition: The following project conditions apply:

1. Protect adjacent materials to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by excavation.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Design Professional and then only after acceptable temporary utility services have been provided.

D. Provide minimum of 14 working day notice to Design Professional, and receive written notice to proceed before interrupting any utility.

E. Operate warning lights as recommended by authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including the recommended installation method, all in accordance with Division 01 and Section 260500 requirements.

B. Electrical Penetration Seals: Submit the following:

1. Shop drawings showing each condition requiring penetration seals. Indicate proposed UL systems materials, anchorage, methods of installation, and actual adjacent construction.
2. A copy of UL illustration of each proposed system indicating manufacturer approved modifications.
3. Manufacturer's specifications, recommendations, installation instructions and maintenance instructions.

1.6 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of electrical service and/or power with the Owner. All associated work to be done at Owner's convenience.
- B. Notify the Design Professional at least 5 working days prior to commencing demolition operations.
- C. Perform demolition in phases as required by Design Professional.

PART 2 PRODUCTS

2.1 MISCELLANEOUS METALS

- A. Fasteners: Zinc-coated, type, grade, and class as required.
- B. Metal Framing: As manufactured by Unistrut or Kindorf unless noted otherwise. Provide framing of sizes required by specific application.

2.2 MISCELLANEOUS LUMBER

- A. Electrical backboards to be 5/8" thick ACX-EXT, Non-Com plywood. Paint both sides and all edges with grey fire-retardant paint.

2.3 MATERIALS OF CONCRETE WORK

- A. Reinforcing Materials:
 1. Reinforcing Bars: Except as otherwise indicated, provide ASTM A 615, deformed, Grade 40 for size numbers 3 through 18; ASTM A 675, plain, Grade 60, for size number 2; sizes as indicated or required.
- B. Reinforcement Supports: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Provide wire bar type supports complying with CRSI recommendations, unless otherwise indicated.

C. Concrete Materials:

1. Portland Cement: ASTM C 150, Type I, except as otherwise indicated.
2. Aggregates: ASTM C 33, except as otherwise indicated.
 - a. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used.
 - b. For rough grouting, provide aggregate which is well graded and 100 percent passing through 3/8" sieve.
3. Water: Clean and free of substances harmful to concrete.

2.4 DESIGN AND PROPORTIONING OF CONCRETE MIXES

A. General: Design electrical work concrete as follows, for each 28-day compressive strength class:

1. 4000 psi Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.35 water/cement ratio.
2. 3000 psi Class: 500 lbs of cement per cu. yd. (5.25 sacks), and 0.46 water/cement ratio.
3. 2500 psi Class: 450 lbs. of cement per cu. yd. (4.75 sacks), and 0.54 water/cement ratio.
4. Rough Grouting Class: 565 lbs. of cement per cu. yd. (6.0 sacks), and 0.60 water/cement ratio.

B. Mix for Patching: Where electrical work requires patching of exposed concrete work which has been cut to accommodate electrical work, provide concrete patching mix which is identical with mix of work being patched (same cement, aggregates, admixtures and proportioning).

2.5 FIRE STOPPING MATERIALS

A. The fire stopping materials used on the entire project shall be selected and submitted by the general contractor. The electrical contractor and all other trades are to coordinate with the general contractor and provide the same manufacturer and type of materials. The following manufacturers and materials listed below are for reference only.

1. Acceptable Manufacturers:
 - Specified Technologies, Inc. (STI) Somerville, NJ
 - Tremco, Inc. Beachwood, OH
 - 3M Inc., Minneapolis, MN
2. Materials:
 - a. Firestop Mortar:
 - STI SpecSeal Mortar
 - Tremco TREMstop-M

- 3M Fire Barrier Mortar
 - b. Intumescent Firestop Sealants and Caulks
 - SpecSeal SSP Putty
 - Tremco TREMstop-WBM
 - 3M Fire Barrier CP-25 WB
 - c. Silicone Firestop Sealants Caulks
 - STI SpecSeal Pensil 100 & 300
 - Tremco Fyre Sil Sealant
 - 3M Fire Barrier 2000 & 2003
 - d. Firestop Putty:
 - STI SpecSeal Firestop Putty Bars & Pads
 - Tremco TREMstop FP Flowable Putty
 - 3M Fire Barrier Firestop Putty
 - e. Firestop Collars:
 - STI SpecSeal Firestop Collars
 - Tremco TREMstop D Combustible Pipe Device
 - 3M Fire Barrier Pipe Device
 - f. Wrap Strip:
 - STI Spec Seal Wrap Strip
 - Tremco TREMstop-WS
 - 3M Fire Barrier WS-195 Wrap Strip
- B. Sleeves shall be Schedule 40, galvanized steel with plain end. Sleeves shall be no more than two sizes larger than single penetrating conduit. For multiple cable or conduit penetrations, make sleeve as small as possible to allow for penetrating items and firestopping material.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine area and conditions under which basic electric materials are to be installed or methods are to be performed and notify Design Professional in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Design Professional.

3.2 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.3 MISCELLANEOUS LUMBER

- A. Cut, fit and place miscellaneous lumber fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Both sides and all edges of all lumber fabrications shall be painted with two (2) coats of grey fire-retardant paint unless noted otherwise.

3.4 INSTALLATION OF CONCRETE WORK

A. Formwork:

- 1. General: Design, construct and maintain formwork to support vertical and lateral loads including pressure of cast-in-place concrete. Construct formwork so that formed concrete will be of required size and shape and in required location. Construct with joints which will not leak cement paste. Form sides and bottoms of concrete work, except where clearly indicated to be cast directly in excavation or against other construction, or on grade or prepared subgrade. Design and construct forms for easy removal without damage to concrete and other work.
 - a. Install chamfer strips at external corners of exposed concrete work.
 - b. Construct forms to retain equipment anchor bolts in accurate locations during placement of reinforcing steel and concrete. Use templates furnished by equipment manufacturers to locate anchor bolts or, where not furnished, locate by accurate measure from certified setting diagrams.

B. Placing Reinforcement:

- 1. General: Comply with requirements and recommendations of specified standards, including "Placing Reinforcing Bars" by CRSI. Place bars where indicated and support to prevent displacement during concrete placement, using appropriate reinforcement supports, properly spaced and wire tied to reinforcing bars.
 - a. Place reinforcement to obtain at least minimum recommended coverages for concrete protection. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- 2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which would reduce bond with concrete.

C. Placing Concrete:

1. Wet wooden forms which have been coated with compound, immediately before concrete, and remove excess water from forms.
2. Strength-Class Application: Comply with the following general application requirements.
 - a. Miscellaneous Supported Work: Provide 3000 PSI class for electrical equipment pads and similar supported work.
 - b. Concrete Grout: Provide rough grouting class for filling voids to be grouted which are too small to be filled effectively with 2500 PSI class concrete.
 - c. Patching General Concrete Work: Match concrete being patched.
3. Deposit concrete continuously or in layers of thickness which will result in no concrete being placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within section. If section cannot be placed continuously, provide construction joints. Deposit concrete as nearly as practicable in its final location, so as to avoid segregation due to rehandling or flowing.
4. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures complying with recommended practices of ACI 309; eliminate voids in work.
5. Bring horizontal surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps and hollows.
6. Cold Weather Placement: Comply with ACI 306. Do not use frozen materials or materials containing ice and snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. When air temperature has fallen or is expected to fall below 40 deg F (4.4 deg C), heat water and aggregates uniformly before mixing, as required to obtain concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (26.7 deg C), at time of placement. Protect concrete work from physical damage and reduced strength resulting from frost, freezing actions, or low temperatures.
7. Finishing Horizontal Surfaces: Float and trowel horizontal (top) surfaces to level, smooth, uniform textured, dense finish, where surface is to remain exposed or receive coating, membrane or other thin-set finish. Otherwise, leave struck-off surface undisturbed; except scratch surfaces which are to receive concrete or mortar topping.
8. Surface Repairs:
 - a. Unexposed Surfaces: Repair significantly damaged and honeycombed areas, and remove major projections and fins where forms have been removed.
 - b. Exposed Surfaces: On formed surfaces which are to be exposed, including those to be coated or covered with membrane or other thin-set applied finish, repair and patch form-tie holes and damaged and honeycombed areas, filling voids with grout and completely removing fins and other projections.

3.5 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from drying and excessively cold and hot temperatures, and maintain in moist condition at relatively constant temperature for period of time necessary for hydration of cement, proper hardening, and achievement of strength requirements as specified.

3.6 MISCELLANEOUS CONCRETE WORK

- A. Concrete Grouting: Space approximately 1" thick between bottom of equipment and top of concrete foundation or base which remains after shimming, shall be filled completely with grouting. Grout shall be made up with sand and cement designed for the purpose which does not shrink on setting up. Exposed surface of grouting shall be finished to make a neat appearance. Grout openings and recesses as indicated, in and around mechanical work and other work which penetrates or adjoins mechanical concrete work, using rough grouting class of concrete mix. Provide formwork where required, and tamp, screed and trowel surfaces. Cure grout as specified for concrete work.
- B. Concrete Bases: In the absence of more specific information, either on drawings, or manufacturer's literature, the bases shall be level, shall have a minimum height above finished floor of 4" and extend 3" beyond the base dimensions of the item of equipment.
- C. Concrete pads placed in existing structures shall be mounted securely to the original substrate with anchor bolts.

3.7 ROUGH-IN

- A. Verify with Design Professional prior to rough-in, exact location of items such as switches, receptacles, clocks, speakers, fire alarm devices, floor boxes, surface-mounted raceways, etc., in finished areas.
- B. Verify with respective equipment supplier prior to rough-in, exact location and method of connection to respective equipment for such items as mechanical equipment, etc.

3.8 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Design Professional.
8. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components.
9. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
10. Provide access panel or doors where units are concealed behind finished surfaces such as drywall and/or plaster construction, etc. Coordinate the access panel type with the Design Professional.
11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope (such as for underground services, etc.).
12. All wiring other than within an item of equipment, to be in raceways unless shown otherwise on Drawings or covered otherwise in these Specifications.
13. Raceways, boxes, cables, conductors, etc., installed in plenum spaces and similar areas shall be supported from the building structure and shall be installed symmetrical with the axis of the space (do not cross room at an angle). Support wires for lay-in type grid ceilings shall not be used to support electrical equipment, raceways, cables, etc.
14. Wiring of Motors and/or Equipment:
 - a. Provide necessary power wiring to motors and/or equipment where shown on Drawings.
 - 1.) Make final "line" connections to respective items of equipment as shown on Drawings.
 - 2.) Provide "Control" wiring, regardless of voltage, only when shown on Electrical Drawings.
 - 3.) In general, all 120, 208, 240, 277, or 480 volt wiring to be construed as power wiring; however, line voltage control wiring shall not be construed as power wiring unless shown on Electrical Drawings.
15. Wiring of Heating, Ventilating, and Air Conditioning Equipment:
 - a. Provide power wiring as shown on Electrical Drawings. In general, this shall consist of power conductors and raceway up to and including connections to line terminals of respective items of equipment.
 - 1.) Where this Contractor furnishes motor starter and/or disconnect switch, this also shall include the power wiring between the load side of starter and/or disconnect switch and line terminals of respective item of equipment.

- 2.) Where other Divisions furnish motor starter and/or disconnect switch (other than factory-mounted, prewired items), this Contractor shall provide power wiring as described in previous paragraph and shall mount respective starter and/or disconnect switch.
- 3.) Where electric heating equipment is involved, wiring responsibilities to be as shown on Electrical Drawings.
- 4.) Control wiring, regardless of voltage characteristics, is not to be construed as power wiring and is not the responsibility of this Contractor unless indicated as such on Electrical Drawings.

In certain cases, such as between a thermostat and a cabinet heater or a unit heater, or between a switch and a small exhaust fan, wiring may be required by this Contractor only if shown on Electrical Drawings.

- 5.) It shall be the responsibility of this Contractor, prior to rough-in of conduits serving mechanical equipment, to verify with respective equipment supplier the required ampacity and quantity of conductors serving the equipment. In the event changes are required from those shown on the Drawings, this information shall be brought to the attention of the Design Professional and authorization obtained from the Design Professional in writing prior to proceeding with the necessary changes. Changes required shall be performed at the expense of the mechanical (HVAC or plumbing) contractor.

16. Wiring of Plumbing Equipment:

- a. Provide necessary power wiring to plumbing equipment requiring same, where shown on Electrical Drawings.
- b. Control equipment such as thermostats, pressure switches, etc., to be furnished, set in place, and wired by other Divisions, unless shown otherwise on Electrical Drawings.
- c. Provide necessary disconnect switches, starters, or contactors where shown on Electrical Drawings. See "MOTOR CONTROL" section of these Specifications.

17. Temperature Control Wiring:

- a. Temperature control wiring, regardless of voltage characteristics, is not the responsibility of this Contractor unless indicated as such on Electrical Drawings or herein described.
 - 1.) In general, the furnishing and installing of all temperature control devices and respective wiring shall be the responsibility of other Divisions.

18. Wiring of Motor Operated or Automatic Doors:

- a. All control devices, such as pushbuttons, limit switches, etc., shall be furnished by other Divisions, and installed and wired by this contractor, unless shown otherwise on the Electrical Drawings.
- b. Power wiring up to and including connection to the overhead door motor system main control panel or junction box, and to the motor from same, if not factory prewired shall be the responsibility of this Contractor.

3.9 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 01 Section "CUTTING AND PATCHING". In addition to the requirements specified in Division 01, the following requirements apply:
1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Demolition of electrical items required to be removed from structure to remain.
 - b. Uncover work to provide for installation of ill-timed work.
 - c. Remove and replace defective work.
 - d. Remove and replace work not conforming to requirements of the Contract Documents.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the Design Professional, uncover and restore work to provide for Design Professional observation of concealed work.
 2. Cut, remove, and legally dispose of electrical equipment, components, and materials, including but not limited to electrical items to be removed and items made obsolete by the new work.
 3. Protect the structure, furnishings, finishes, and adjacent materials not to be removed.
 4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
 6. Patch new and/or existing finished surfaces and building components using new materials matching existing materials and using workmen skilled in respective trade.
 7. Where existing construction such as floors, walls, ceilings, etc., must be cut to relocate, remove or add raceways and/or equipment, such construction to be restored to original condition to satisfaction of Design Professional by this Contractor using workmen skilled in respective trade.
 8. General penetrations through walls, floors, slab, etc. will be patched with materials to match the surrounding surface (i.e. vinyl concrete patch for concrete surfaces, joint and patching compound for dry wall surfaces, etc.). If the penetrated surface is a fire or smoke barrier, refer to "Installation of Fire Stopping Materials" in this section.

3.10 INSTALLATION OF FIRE-STOPPING MATERIAL

- A. General:
1. All fire and smoke rated walls and floors penetrated by electrical raceways, exposed conductors, etc. shall be properly sleeved and fire sealed. See Division 7 "Firestopping". All firestop system types shall be by same manufacturer to fullest extent possible.
 2. All fire stopping will be installed in accordance to the U.L. rated system designed for the application.

3. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
4. Grout, Mortar, or Gypsum products shall not be installed in lieu of firestopping material specified here.

B. Sleeves:

1. Wall and floor opening shall be made as small as possible. Install sleeves during the erection of concrete or masonry walls. Sleeve shall be grouted in using material to match surrounding surface. Install electrical raceway, exposed conductors, etc. through sleeve and install fire stopping, intumescent material.

C. Penetrations - Provide Firestopping:

1. Where penetrations including conduit, cable, wire, or other elements which pass through one or both outer surfaces of a fire rated floor or wall.
2. Except for floor on grade, where a penetration occurs through a structural floor or roof and a space would otherwise remain open between the surfaces of the penetration and the edge of the adjoining structural floor or roof.
3. Where a penetration occurs through fire-rated walls, or partitions of hollow-type construction, provide fire stopping to completely fill spaces around the penetration, on each side of the wall or partition.
4. These requirements for penetrations shall apply whether or not sleeves have been provided, and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved, fire stop annular space, if any, between sleeve and wall opening.

- D. Provide fire stopping to fill miscellaneous voids and blank openings in fire-rated construction where conduit, cable, wire or equipment has been removed.

3.11 SELECTIVE DEMOLITION AND ALTERATION OF EXISTING ELECTRICAL SYSTEMS

A. Demolition Definitions:

1. Under demolition notes, several words and phrases are used. These shall be interpreted to mean as follows:
 - a. Abandon: Disconnect designated equipment and remove respective conductors back to source, such as a panelboard, distribution panel, switchboard, switchgear, etc. Alter respective legend accordingly.
 - b. Disconnect: Disconnect designated equipment and remove respective branch circuit wiring and affected exposed electrical equipment, such as boxes, raceways, control, etc.
 - 1.) Remove conductors back to source such as panelboard, etc. Alter respective legend accordingly.

- 2.) Remove exposed raceway. When in unfinished areas such as mechanical equipment rooms, remove back to source. When in finished spaces, remove only that raceway which is exposed.
 - 3.) Where raceway is above an existing suspended, accessible ceiling and that ceiling grid is being reused or replaced, remove the exposed raceway in the affected area. Concealed homeruns are to remain and may be reused at Contractor's option.
 - c. Disconnect and Reconnect: Disconnect designated items, remove and store same where necessary, and then reinstall item and reconnect to existing branch circuit and control.
 - d. Remove Branch Circuit and/or Feeder: Remove conductor and respective raceway, fittings, boxes, etc.
- B. Where existing building construction is to be altered to accommodate the planned renovations and/or an addition(s), alter existing electrical service and distribution system, communications systems, fire alarm system, etc., as shown on the drawings and as required for proper operation of the altered system.
- C. Where existing accessible ceiling grid panels and grid support members are removed to permit the installation of new conduit, boxes, etc., it shall be the responsibility of this Contractor to reinstall the panels and grid support system to the satisfaction of the Design Professional. Damaged items shall be replaced at no cost to the Owner.
- D. Remove all existing affected electrical equipment, devices, fixtures, boxes, etc. which are not incorporated into or are not necessary for the operation of new and/or existing electrical systems, making sure that no remaining fixtures, devices, or appliances are left without service.
- E. Make sure that no remaining fixtures, devices, etc. within the renovated area or adjacent areas are left without service.
1. Services and/or power outages and cutovers to be coordinated Design Professional and Owner and done at Owner's convenience.
 2. Modify existing "systems" as required to accommodate added equipment.
 3. Remove abandoned accessible surface-mounted boxes and raceway. Abandoned accessible surface raceway shall be removed complete back to source.
 4. Where an abandoned raceway penetrates floor, slab, wall, etc. raceway shall be cut below the surface. Seal the opening and restore respective surface to match surrounding surface as directed.
 5. Where an abandoned raceway is not accessible, the raceway shall remain. Any accessible portions penetrating out of wall, floor, slab, etc. shall be cut off below the surface. Seal the opening and restore the respective surface to match the surrounding surface as directed.
 - a. Perform cutting and patching required for demolition in accordance with Division 01 and Division 02 section "Cutting and Patching".
 6. Flush mounted outlet boxes which are abandoned or used for junction boxes and are not concealed by new construction shall have openings covered by a blank, stainless steel plate.

7. Where an existing distribution center is altered, provide a new, accurate, typed legend.
 8. Where work cannot be executed during normal working hours, this Contractor shall include in the Base Bid all necessary overtime pay to execute this contractors contract.
- F. All electrical equipment removed and not scheduled for reuse shall be turned over to the Owner at the construction site for salvage. All items deemed not salvageable by the Owner shall become the property of this Contractor and shall be removed from the site within 72 hours.

END OF SECTION 260501

SECTION 260513 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.3 DEFINITIONS

- A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
- B. NETA ATS: Acceptance Testing Specification.
- C. Sheath: A continuous metallic covering for conductors or cables.

1.4 SUBMITTALS

- A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

1.5 QUALITY ASSURANCE

- A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable. Include individual resume(s) and certification of cable splicer(s) with submittals, company resumes are not acceptable.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify KSU Engineer no fewer than 2 weeks (10 days) in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without KSU Engineer's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2 and NFPA 70.
- C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Aetna Insulated Wire, Inc.
 2. General Cable; General Cable Corporation.
 3. Kerite Co. (The).
 4. Okonite Company (The).
 5. Prysmian Power Cables and Systems USA, LLC.
 6. Rome Cable Corporation.
 7. Southwire Company.
 8. Superior Essex Inc.
- B. Cable Type: Type MV 105.
- C. Conductor Insulation: Ethylene-propylene rubber.
 1. Voltage Rating: 15 kV.
 2. Insulation Thickness: 133 percent insulation level.
- D. Conductor: Copper.
- E. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682, and ICEA S-94-649.
- F. Conductor Stranding: Compact round, concentric lay, Class B.
- G. Strand Filling: Conductor interstices are filled with impermeable compound.
- H. Shielding: Copper tape minimum 5 mil thickness with minimum 25% overlap, helically applied over semiconducting insulation shield.
- I. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors.

1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.
2. Cable Sheath: Interlocked aluminum applied over cable.
3. Armor shall be jacketed with sunlight-resistant PVC, color shall be selected by KSU electrical engineer.
4. Shall contain copper ground conductor, minimum 1/0awg.
5. Individual taped shielded conductors shall also have a PVC jacket.

2.3 CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.
 2. Cooper Power Systems, an Eaton business.
 3. Raychem; a brand of nVent.
 4. Thomas & Betts Corporation; A Member of the ABB Group.
- B. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.
- C. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.4 SOLID TERMINATIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Power Systems, an Eaton business.
 2. Raychem; a brand of nVent.
 3. Thomas & Betts Corporation; A Member of the ABB Group.
- B. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
1. Compound-filled, cast-metal-body, metal-clad cable terminator for metal-clad cable with external plastic jacket.
 2. Heat-shrink sheath seal kit with phase- and ground-conductor re-jacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
- C. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
1. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
 2. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape; cold-

shrink-rubber sleeve; or heat-shrink, plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

2.5 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Power Systems, an Eaton business.
 - 2. Raychem; a brand of nVent.
 - 3. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
- D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
 - 1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
 - 2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
 - 3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
 - 4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
- F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

2.6 SPLICE KITS

- A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Raychem; a brand of nVent.
- C. Standard: Comply with IEEE 404.
- D. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
 - 1. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket heat shrink splices shall be Raychem (HVS) splice kit or equivalent.

2.7 MEDIUM-VOLTAGE TAPES

- A. Description: Electrical grade, insulating tape rated for medium voltage application.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M.
 - 2. Cooper Power Systems, an Eaton business.
 - 3. Raychem; a brand of nVent.
 - 4. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 deg C operation. Minimum 3/4 inch wide.
- D. Silicone rubber-based, 12-mil self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches (38 mm) wide.
- E. Insulating-putty, 125-mil elastic filler tape. Minimum 1-1/2 inches wide.

2.8 ARC-PROOFING MATERIALS

- A. Description: Fire retardant, providing arc flash protection.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M.
 - 2. Cooper Power Systems, an Eaton business.
 - 3. Raychem; a brand of nVent.
 - 4. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

- D. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.
- E. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide. Scotch brand 27 or 69 or equivalent.

2.9 FAULT INDICATORS

- A. Indicators: Automatically reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

2.10 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 and ICEA S-94-649 before shipping.
- B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.
 - 1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
 - 2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
 - 3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.

4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.
- G. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- H. Install cable splices at pull points and elsewhere as indicated; use standard kits. Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.
- I. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.
- J. Install separable insulated-connector components as follows:
 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
 3. Standoff Insulator: At each terminal junction, with one on each terminal.
- K. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
 1. Clean cable sheath.
 2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
 3. Smooth surface contours with electrical insulation putty.
 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 5. Band arc-proofing tape with two layers of 1-inch- wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.
- L. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."
- M. Install fault indicators on each phase where indicated.
- N. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- O. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform direct-current High Potential or VLF test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
- C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 4 - KSU Design Requirements

- 4.1 The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - A. All cable must be 15kV rated, 350 Kcmil, MV-105, 133% insulation, copper, EPR insulation, PVC jacket. All single conductor cables will be fire taped in manholes or hand holes. All cables shall have fault indicators placed on them at transformers and switches (automatic current reset and 800A trip rating).
 - B. Interlocked Armored Cable (IAC):
 - 1. The nonmetallic insulation screen shall be an extruded semi-conducting EPR material. The metallic shield shall be a 5 mil bare copper tape applied helical over the extruded insulation shield with an average minimum overlap of 25% of the tape width. The individual conductors shall have a continuous extruded jacket being moisture, heat and abrasion resistant and shall be made of polyvinyl chloride (PVC). The three phase conductors shall be cable wound with fillers and with a grounding conductor in one or three outer interstice and covered with a binder tape. A single strip of interlocked armor of aluminum shall be applied over the assembly. The armor shall be covered with a colored PVC jacket. All new cables must be color coded to all other cables in the designated loop. KSU Electrical Engineers will designate the color/design for the loop cables.
 - 2. Where single conductor cables are broken out of the interlocked armor sheath for termination purposes, the interface shall be effectively sealed to prevent entrance of moisture. Raychem (CBR) heat-shrink cable breakout boot.
 - C. Splices:

1. Splices shall utilize “Raychem” brand heat-shrink splice kit (HVS), specifically designed for the dimensions and characteristics of the cable to which they are being applied.
- D. Dead-Break Cable Terminations:
1. Dead-break cable terminations shall be an elbow type unit with a 600A continuous-current rating as manufactured by Cooper Industries or Elastimold.
 2. The elbows shall have a capacitive test point.
- E. Load-Break Cable Terminations:
1. Load-Break Cable Terminations are not typically used at KSU, they are the exception and shall be discussed with KSU Engineer.
- F. Moisture prevention:
1. To prevent moisture, water and rodents from entering the high voltage switch gear conduits, any conduits or ducts that enter the space from below grade should be terminated at the point of entry into the space. Conduits should be sealed using Linkseals and Raychem inflatable seals (Note: Certain circumstances may require other Raychem products.)
 2. The area around conductors that are within the conduits should be sealed with Raychem CO2 “inflate-a-seal” (RDSS style). Some method, cable tray or j-box, with drain should be used to drain off any water that may infiltrate through or around the conduits into the room. (Note: Certain circumstances may require other Raychem products.)
- G. Terminations:
1. Terminations shall utilize “Raychem” brand heat-shrink terminations specifically designed for the dimensions and characteristics of the cable to which they are being applied.
- H. Contractor medium Voltage Cable Splicing Requirements:
1. Contractor shall have undergone Raychem provided training seminars for the application of medium-voltage termination, splicing and wye-tap kits and have proof of such. EC shall provide proof that they have been certified within the past three years by Raychem. EC shall provide two pieces approximately 4’ in length of 15kv shielded cable and one Raychem splice kit matching the cable dimensions. The EC shall then schedule a cable splicing demonstration with a University representative.
- I. Cables in Manholes - Fireproof exposed medium voltage cable in junction boxes and manholes where there are multiple cable runs as follows:
1. Apply one half-lapped wrap of fire retardant electric arc proofing tape over exposed areas of cable extended one inch into ducts (Scotch brand 77)
 2. Secure ends of fireproofing tape with two wraps of glass cloth tape (Scotch Brand 27 or 69).

END OF SECTION 260513

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Mineral-insulated cable, Type MI, rated 600 V or less.
4. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.

1.3 DEFINITIONS

- A. RoHS: Restriction of Hazardous Substances.
- B. VFC: Variable-frequency controller.

1.4 SUBMITTALS

- A. Product Data: For each type of product.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.
2. American Bare Conductor.
3. Belden Inc.
4. Cerro Wire LLC.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Okonite Company (The).
8. Service Wire Co.
9. Southwire Company.
10. WESCO.
11. West Penn.

- C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

- E. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.

2.2 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath in 6' length or less from J-box to lighting fixture or as approved by KSU Engineer.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems; a part of Atkore International.
2. Alpha Wire Company.
3. American Bare Conductor.
4. Belden Inc.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Okonite Company (The).
8. Service Wire Co.
9. Southwire Company.
10. WESCO.

- C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multicircuit with color-coded conductors.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:

1. Type THHN/THWN-2: Comply with UL 83.

H. Armor: Steel, interlocked.

I. Jacket: PVC applied over armor.

2.3 MINERAL-INSULATED CABLE, TYPE MI

A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. KME America, Inc.
2. Pentair.
3. Watlow Electric Manufacturing Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. UL 2196 for fire resistance.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper.

E. Insulation: Compressed magnesium oxide.

F. Sheath: Copper.

2.4 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. 3M Electrical Products.
 - 2. AFC Cable Systems; a part of Atkore International.
 - 3. Gardner Bender.
 - 4. Hubbell Power Systems, Inc.
 - 5. Ideal Industries, Inc.
 - 6. ILSCO.
 - 7. NSi Industries LLC.
 - 8. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 9. Service Wire Co.
 - 10. TE Connectivity Ltd.
 - 11. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: One hole with standard barrels.
 - 3. Termination: Crimp.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders and Branch Circuits: Copper; solid for No. 14 AWG and smaller; stranded for No. 12 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. All Wiring: Type THHN/THWN-2, single conductors in raceway.
- B. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each of the following tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Inspect compression-applied connectors for correct cable match and indentation.
 - c. Inspect for correct identification.
 - d. Inspect cable jacket and condition.
- B. Cables will be considered defective if they do not pass tests and inspections.

PART 4 - KSU Design Requirements

- 4.1 The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. All outdoor locations (above or below grade) must use gel filled wire nuts or Raychem gel splice packs (i.e. - GHFC-1-90, GHFC-2-90, etc...) for all splice points. Certain circumstances may require other Raychem products. For splices over 1000V use the GTAP by Tyco Electronics.
 - 2. All floor penetrations must be sleeved and fire stopped. (Note: Certain circumstances may require other Raychem products.)
 - 3. Any wiring not in conduit must be rated as plenum, and if in cable tray, it must be rated accordingly.
 - 4. All conductor insulation must be rated for 600v.
 - 5. MC and BX are permitted only in special circumstances and will require written permission from KSU's Electrical Engineer. If MC cable is used, the final home run to electrical panel must be with THHN stranded wire. When exceptions are permitted, MC cable can be used from a junction box out to the loads. Any vertical cable should be supported with some type of strain relief per NEC.
 - 6. Connections in No. 10 and smaller wire shall be made with threaded on plastic or nylon insulated wire nuts. Joints in #8 and larger conductors shall be made with pressure type mechanical connectors with 600V heat shrink covering.
 - 7. All control cabling (not 600V class) shall be preferably installed in conduit. All low voltage, teledata, control, security cabling may be installed utilizing j-hooks where not

subject to damage (above lay-in ceilings, at heights above 10' where approved by KSU engineer, etc.) these cables shall be plenum rated.

8. Under carpet cables are not permitted at KSU.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.3 SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Ground rods.
 - 2. Ground rings.
 - 3. Grounding arrangements and connections for separately derived systems..
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1) Ground rods.
 - 2) Ground rings.
 - 3) Grounding arrangements and connections for separately derived systems.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advanced Lightning Technology, Ltd.
 - 2. Burndy; Part of Hubbell Electrical Systems.
 - 3. Dossert; AFL Telecommunications LLC.
 - 4. ERICO; a brand of nVent.
 - 5. Fushi Copperweld Inc.
 - 6. Galvan Industries, Inc.; Electrical Products Division, LLC.
 - 7. Harger Lightning & Grounding.
 - 8. ILSCO.
 - 9. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 10. Robbins Lightning, Inc.
 - 11. Siemens Industry, Inc., Energy Management Division.
 - 12. Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- J. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- K. Straps: Solid copper, copper lugs. Rated for 600 A.
- L. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal onetwo-piece clamp.
- M. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- N. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with zinc-plated bolts.
 - a. Material: Tin-plated aluminum.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install barecopper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Exothermic welded connectors as indicated.
 - 3. Connections to Structural Steel: Exothermic welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Install grounding electrode(s) at the transformer location. The electrode shall be connected to the equipment grounding conductor and to the frame of the transformer.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes: Install a driven ground rod through manhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded,

hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

- D. Pad-Mounted Transformers and Switches: Install four ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- C. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- D. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 FENCE GROUNDING (Delete if not project applicable)

- A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
 - 1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
 - a. Gates and Other Fence Openings: Ground fence on each side of opening.
 - 1) Bond metal gates to gate posts.

- 2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.
- B. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
- C. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
- D. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- E. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 2. Use exothermic welds for all below-grade connections.
 3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

G. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column or indicated item, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel unless otherwise noted on drawings.
2. Bury ground ring not less than 24 inches from building's foundation.

H. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor to engage a qualified third party testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Retain "Perform tests and inspections" Paragraph below to require Contractor to perform tests and inspection and retain option to require Contractor to arrange for assistance of a factory-authorized service agent.

D. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

PART 4 - KSU Design Requirements

4.1 The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.

1. Underground conductors shall be bare tinned copper No. 2/0 AWG minimum, buried 24" minimum below grade.

2. Ground rods shall be copper or tinned copper minimum 5/8 x 10'. Drive rods until top of rod is 4 inches below finished grade.
3. Isolated ground conductors shall have green colored insulation with a continuous yellow stripe.
4. All connections to buried or inaccessible ground rods and to structural steel shall be welded (CAD-Weld).
5. Manholes: Ground rods shall be driven in manholes, equipment ground run in ductbanks with medium voltage conductors shall be welded to this ground rod. All exposed metal parts (ladder, cable racks, pulling irons...) shall be connected to this ground using minimum No. 1/0 AWG.
6. Pad-mounted Transformers and pad-mounted medium voltage sectionalizing switches: EC shall utilize four ground rods around perimeter of transformer pad connected back into transformer ground connection.
7. Install insulated equipment ground in all feeder and branch circuits.
8. All junction boxes and pullboxes shall be grounded with the equipment grounding conductor running in the conduit.
9. When a new building service is installed the grounding system shall be evaluated and supplemented to ensure metal water pipe, building structure and additional ground rods are utilized. The additional ground rods shall consist of a minimum three rods spaced at least one rod length apart.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Conduit supports on roof non-penetration product specifically designed for conduit support.
2. Product shall be approved by roofing manufacturer to retain roofing warranty.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.

2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
 1. Hangers. Include product data for components.
 2. Slotted support systems.
 3. Equipment supports.
- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. B-line, an Eaton business.
 - c. CADDY; a brand of nVent.
 - d. Flex-Strut Inc.
 - e. Gripple Inc.
 - f. GS Metals Corp.
 - g. G-Strut.
 - h. Haydon Corporation.
 - i. Metal Ties Innovation.
 - j. MIRO Industries.
 - k. Thomas & Betts Corporation; A Member of the ABB Group.
 - l. Unistrut; Part of Atkore International.

- m. [Wesanco, Inc.](#)
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 4. Channel Width: 1-1/4 inches.
 - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Cooper Industries, Inc.](#)
 - b. [Flex-Strut Inc.](#)
 - c. [Haydon Corporation.](#)
 - d. [MKT Metal Manufacturing.](#)
 - e. [Thomas & Betts Corporation; A Member of the ABB Group.](#)
 - f. [Unistrut; Part of Atkore International.](#)
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Channel Material: 6063-T5 aluminum alloy.
 - 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 - 5. Channel Width: Selected for applicable load criteria.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Nonmetallic Slotted Support Systems (where instructed by KSU Engineer): Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Allied Tube & Conduit; a part of Atkore International.](#)
 - b. [B-line, an Eaton business.](#)
 - c. [Fabco Plastics Wholesale Limited.](#)
 - d. [G-Strut.](#)
 - e. [Haydon Corporation.](#)
 - f. [Seasafe, Inc.; AMICO, a Gibraltar Industries Company.](#)

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Width: Selected for applicable load criteria.
 4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 5. Fitting and Accessory Materials: Same as those for channels and angles.
 6. Rated Strength: Selected to suit applicable load criteria.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) B-line, an Eaton business.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA 101
 3. NECA 102.
 4. NECA 105.
 5. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 50 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete." And/or Section 033053 "Miscellaneous Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
1. Tunnel anchors are to be carbon steel 3/8" diameter by 2-3/4" long with a minimum 1-5/8" embedment in concrete. No lead anchors are allowed on campus.
 2. All hardware used outdoors, in damp/wet locations and in tunnels must be stainless steel. No fiberglass struts shall be used anywhere on campus without written consent of the KSU Engineer.
 3. All electrical pathways (conduit, cable tray, buss-duct etc) and equipment (panels, lights, transformers, etc.) must be supported independently of any mechanical systems or ceiling grid – no light-to-grid locking tabs are allowed. All four corners of lay-in fixtures must be independently supported from the structure. For "can" fixtures only one independent support from structure is required.
 4. Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components.
 5. Install trapeze type supports fabricated with galvanized steel slotted sized so capacity can be increased by 50% in future without exceeding specified design load limits. Secure raceway and cables to these hangers with conduit clamps. Extend ground conductor to these supports when supporting non-metallic cable/conduit.
 6. All light pole bases must use rebar and comply with the manufacturer's recommended installation methods regarding the type of concrete, depth and size of the base, etc... All

light pole bases must be designed by a qualified Structural Engineer. Refer to KSU Standard Electrical Details.

7. No PVC ratcheting supports shall be used.
8. Design details provided with this design guide shall be considered a preferred style – actual rebar sizes and structural dimensions shall be calculated and stamped by a licensed structural P.E. and submitted as a shop drawing to the Office of the University Architect.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
3. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adalet, Inc.
 - b. AFC Cable Systems; a part of Atkore International.
 - c. Allied Tube & Conduit; a part of Atkore International.
 - d. Amp.
 - e. Anamet Electrical, Inc.
 - f. Appleton Electric Co.
 - g. Arlington Industries Inc.
 - h. Calconduit.
 - i. Electri-Flex Company.
 - j. FSR Inc.
 - k. Hubbell, Inc.
 - l. Korkap.
 - m. NEC, Inc.
 - n. Opti-Com Manufacturing Network, Inc (OMNI).
 - o. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - p. Patriot Aluminum Products, LLC.
 - q. Perma-Cote.
 - r. Picoma Industries, Inc.
 - s. Plasti-Bond.
 - t. Republic Conduit.
 - u. Southwire Company.
 - v. Thomas & Betts Corporation; A Member of the ABB Group.
 - w. Western Tube and Conduit Corporation.
 - x. Wheatland Tube Company.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. ARC: Comply with ANSI C80.5 and UL 6A.
5. IMC: Comply with ANSI C80.6 and UL 1242.
6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch, minimum.
7. EMT: Comply with ANSI C80.3 and UL 797.
8. FMC: Comply with UL 1; zinc-coated steel.
9. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems; a part of Atkore International.
 - b. Allied Tube & Conduit; a part of Atkore International.
 - c. Anamet Electrical, Inc.
 - d. Calconduit.
 - e. Electri-Flex Company.
 - f. FSR Inc.
 - g. Korkap.
 - h. NEC, Inc.
 - i. NewBasis.
 - j. Opti-Com Manufacturing Network, Inc (OMNI).
 - k. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - l. Patriot Aluminum Products, LLC.
 - m. Perma-Cote.
 - n. Picoma Industries, Inc.
 - o. Plasti-Bond.
 - p. Republic Conduit.
 - q. Southwire Company.
 - r. Thomas & Betts Corporation; A Member of the ABB Group.
 - s. Western Tube and Conduit Corporation.
 - t. Wheatland Tube Company.
2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
6. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew.
7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems; a part of Atkore International.
 - b. Anamet Electrical, Inc.
 - c. Arco Corporation.
 - d. CANTEX INC.
 - e. CertainTeed Corporation.
 - f. Condux International, Inc.
 - g. Electri-Flex Company.
 - h. FRE Composites.
 - i. Kraloy.
 - j. Lamson & Sessions.
 - k. Niedax Inc.
 - l. RACO; Hubbell.
 - m. Thomas & Betts Corporation; A Member of the ABB Group.
 - n. Topaz Electric; a division of Topaz Lighting Corp.
2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. ENT: Comply with NEMA TC 13 and UL 1653.
4. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.
6. Rigid HDPE: Comply with UL 651A.
7. Continuous HDPE: Comply with UL 651A.
8. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems; a part of Atkore International.
 - b. Anamet Electrical, Inc.
 - c. Arco Corporation.
 - d. CANTEX INC.
 - e. CertainTeed Corporation.
 - f. Condux International, Inc.
 - g. Electri-Flex Company.
 - h. FRE Composites.
 - i. Kraloy.
 - j. Lamson & Sessions.
 - k. Niedax Inc.
 - l. RACO; Hubbell.
 - m. Thomas & Betts Corporation; A Member of the ABB Group.
 - n. Topaz Electric; a division of Topaz Lighting Corp.
2. Fittings, General: Listed and labeled for type of conduit, location, and use.

3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
 - a. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. B-line, an Eaton business.
 2. Hoffman; a brand of nVent.
 3. MonoSystems, Inc.
 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 and/or Type 3R unless otherwise indicated, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged for type 3R, screw-cover for type 1 unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Allied Moulded Products, Inc.
 2. Hoffman; a brand of nVent.
 3. Lamson & Sessions.
 4. Niedax Inc.
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.
- D. Tele-Power Poles:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Panduit Corp.
 - b. Wiremold / Legrand.

Spec note: Engineer to choose one or the other.

- 2. Material: Galvanized steel with ivory baked-enamel finish or Aluminum with clear anodized finish.
- 3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Adalet.
 2. Crouse-Hinds, an Eaton business.
 3. EGS/Appleton Electric.
 4. Erickson Electrical Equipment Company.
 5. FSR Inc.
 6. Hoffman; a brand of nVent.
 7. Hubbell Incorporated.
 8. Hubbell Incorporated; Wiring Device-Kellems.
 9. Kraloy.
 10. Milbank Manufacturing Co.
 11. MonoSystems, Inc.
 12. Oldcastle Enclosure Solutions.
 13. O-Z/Gedney; a brand of Emerson Industrial Automation.
 14. Plasti-Bond.
 15. RACO; Hubbell.
 16. Spring City Electrical Manufacturing Company.
 17. Stahlin Non-Metallic Enclosures.
 18. Thomas & Betts Corporation; A Member of the ABB Group.
 19. Topaz Electric; a division of Topaz Lighting Corp.
 20. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
1. Material: Cast metal or sheet metal.
 2. Type: Fully adjustable.
 3. Shape: Rectangular.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep for power 5 inches square x 2-1/8 inches deep for telecom.
- L. Gangable boxes are allowed.
- M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 and/or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- N. Cabinets:
 - 1. NEMA 250, Type 1 and/or Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Armorcast Products Company.](#)
 - b. [NewBasis.](#)
 - c. [Oldcastle Enclosure Solutions.](#)
 - d. [Oldcastle Precast, Inc.](#)
 - e. [Quazite: Hubbell Power Systems, Inc.](#)
 - 2. Standard: Comply with SCTE 77.

3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or PVC coated GRC.
2. Concealed Conduit, Aboveground: GRC or PVC coated GRC.
3. Underground Conduit: RNC, Type EPC-40-PVC or Type EPC-80-PVC,.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 - e. Garages
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

- E. Install surface raceways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 90 deg F.

3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction. Pull point shall be no more than 200 linear feet.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 5. Change from ENT to PVC coated GRC before rising above floor.
- M. Stub-Ups to Above Recessed Ceilings:
1. Use EMT, IMC, or GRC for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- T. Cut conduit perpendicular to the length and deburr. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- V. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Conduit extending from interior to exterior of building.
 4. Conduit extending into pressurized duct and equipment.
 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 6. Where otherwise required by NFPA 70.
- Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Z. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches⁷² inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- EE. Locate boxes so that cover or plate will not span different building finishes.
- FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- HH. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

Editor Note: Verify 312000 is used by Architect.

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

- b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
- 6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of limestone 57 stone, graded from and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

Spec Note: verify 078413 is used by Architect.

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

PART 4 - KSU Design Requirements

4.1 The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.

1. Boxes: All exposed outdoor boxes must be cast weatherproof type; all surface mounted indoor electric boxes in damp/wet locations below 8' AFF must be cast weatherproof type. Electrical junction boxes must be placed no further than 200 feet apart and with no more than three (3) 90° turns. Every circuit must enter a space at an electric junction box within the room. Boxes in public corridors, placed with the intent of housing a housecleaning general receptacle, shall be placed no more than 40' from the end of a hallway or from next receptacle.
2. All boxes shall be labeled as to the conductors that are contained within.
3. All conduit fittings shall be steel type no cast fittings allowed.
4. Home run conductor pathways must be no smaller than ¾" conduit – MC Cable shall not be used for home runs.
5. Floor boxes will not be allowed without written permission from KSU Engineer.
6. Liquid tight flexible metal conduit shall be used in wet locations where flexibility is required and for all motor and transformer connections.
7. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated.
8. Change from sch40 PVC conduit in ground (slab) to PVC coated GRC before rising above grade (floor slab).
9. All floor and wall penetrations are to be fire stopped as required to maintain fire ratings.
10. Do not install conduits closer than 6" to parallel runs of any pipes carrying materials hotter than 200°F.
11. Sleeves through walls shall be 2 trade sizes larger than the conduit to be installed. Sleeves should be grouted into the walls and floors. The space between the sleeve and conduit should be fire stopped.
12. Liquid-Tight flexible metal conduit shall be used on flexible conduit exposed to the outdoors or in damp or wet locations and in raised floor computer room applications.
13. Aluminum conduit will not be permitted without written permission from KSU Engineer.
14. Whenever possible conceal conduit in concealed walls ceilings, pipe chases, etc.
15. Conduit may be exposed in mechanical rooms, electrical rooms, and custodial closets.
16. When exposed raceway is necessary in finished spaces conduit or surface metal raceway shall be used and be painted to match existing finishes.
17. All conduit shall run parallel and perpendicular to structural members and framing.
18. All exterior boxes and boxes in wet or corrosive atmospheres shall be cast type.
19. All empty raceways shall have pull-strings installed and tied down at either end.
20. All penetrations into tunnels, manholes or building foundations below grade shall utilize link-seal devices. Means shall be used such as sloping conduits away from tunnel and or building to minimize chances of water entry.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Precast manholes.
8. Cast-in-place manholes.
9. Utility structure accessories.

1.3 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 1. Two or more ducts installed in parallel, with or without additional casing materials.
 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 1. Include duct-bank materials, including spacers and miscellaneous components.
 2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 3. Include accessories for manholes, handholes, boxes, and other utility structures.

4. Include underground-line warning tape.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

- a. Include plans, elevations, sections, details, attachments to other work, and accessories.
- b. Include duct entry provisions, including locations and duct sizes.
- c. Include reinforcement details.
- d. Include frame and cover design and manhole chimneys.
- e. Include ladder details.
- f. Include grounding details.
- g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
- h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

- a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
- b. Include duct entry provisions, including locations and duct sizes.
- c. Include cover design.
- d. Include grounding details.
- e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- D. Source quality-control reports.
- E. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify KSU Electrical Engineer no fewer than two weeks in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without KSU Electrical Engineer written permission.
- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Coated Steel Conduit: PVC-coated GRC.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Anamet Electrical, Inc.
 - 4. Calconduit.
 - 5. Electri-Flex Company.
 - 6. FSR Inc.
 - 7. Korkap.
 - 8. NEC, Inc.
 - 9. Opti-Com Manufacturing Network, Inc (OMNI).
 - 10. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 11. Perma-Cote.
 - 12. Picoma Industries, Inc.
 - 13. Plasti-Bond.
 - 14. Republic Conduit.
 - 15. Southwire Company.
 - 16. Thomas & Betts Corporation; A Member of the ABB Group.
 - 17. Topaz Electric; a division of Topaz Lighting Corp.
 - 18. Western Tube and Conduit Corporation.
 - 19. Wheatland Tube Company.

- D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. [ARNCO Corp.](#)
 - 2. [Beck Manufacturing.](#)
 - 3. [CANTEX INC.](#)
 - 4. [CertainTeed Corporation.](#)
 - 5. [Condux International, Inc.](#)
 - 6. [Crown Line Plastics.](#)
 - 7. [ElecSys, Inc.](#)
 - 8. [Electri-Flex Company.](#)
 - 9. [Endot Industries Inc.](#)
 - 10. [IPEX USA LLC.](#)
 - 11. [Lamson & Sessions.](#)
 - 12. [Manhattan/CDT.](#)
 - 13. [National Pipe & Plastics.](#)
 - 14. [Opti-Com Manufacturing Network, Inc \(OMNI\).](#)
 - 15. [Spiraduct/AFC Cable Systems, Inc.](#)
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.3 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
 - 1. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Allied Tube & Conduit; a part of Atkore International.](#)
 - b. [CANTEX INC.](#)
 - c. [Carlton; a brand of Thomas & Betts Corporation.](#)
 - d. [IPEX USA LLC.](#)
 - e. [PenCell Plastics.](#)
 - f. [Underground Devices, Inc.](#)
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
- B. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Christy Concrete Products.
 - 2. Elmhurst-Chicago Stone Co.
 - 3. Lindsay Precast.
 - 4. Oldcastle Precast, Inc.
 - 5. Rinker Group, Ltd.
 - 6. Riverton Concrete Products.
 - 7. Utility Concrete Products, LLC.
 - 8. Utility Vault Co.
 - 9. Wausau Tile Inc.
- C. Comply with ASTM C 858 for design and manufacturing processes.
- D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and stainless steel, cover-securing bolts.
- E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- F. Cover Legend: Molded lettering, "ELECTRIC." or as indicated for each service.
- G. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- H. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - 1. Extension shall provide increased depth of 12 inches.
 - 2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
- I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- J. Handhole Maximum size: 36"x48" x 36" deep.

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. [Armorcast Products Company.](#)
 2. [MacLean Highline.](#)
 3. [NewBasis.](#)
 4. [Oldcastle Enclosure Solutions.](#)
 5. [Quazite: Hubbell Power Systems, Inc.](#)
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray.
- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by stainless steel locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50 minimum 20,000 lb. rating.
- H. Cover Legend: Molded lettering, "ELECTRIC".
- I. Handhole Maximum size: 36"x48"x36" deep.

2.6 PRECAST MANHOLES

- A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
- B. [<Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
1. [Carder Concrete Products.](#)
 2. [Christy Concrete Products.](#)
 3. [Elmhurst-Chicago Stone Co.](#)
 4. Lindsay Precast.
 5. [Oldcastle Precast, Inc.](#)
 6. [Rinker Group, Ltd.](#)
 7. [Riverton Concrete Products.](#)
 8. [Utility Concrete Products, LLC.](#)
 9. [Utility Vault Co.](#)
 10. [Wausau Tile Inc.](#)
- C. Comply with ASTM C 858.
- D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.
 2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.
- F. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.
- G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.7 UTILITY STRUCTURE ACCESSORIES

- A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. [BILCO Company \(The\).](#)
 2. [Campbell Foundry Company.](#)
 3. [Carder Concrete Products.](#)
 4. [Christy Concrete Products.](#)
 5. [EJ.](#)
 6. [Elmhurst-Chicago Stone Co.](#)
 7. [McKinley Iron Works, Inc.](#)
 8. [Neenah Foundry Company.](#)
 9. [NewBasis.](#)
 10. [Oldcastle Precast, Inc.](#)
 11. [Osburn Associates, Inc.](#)
 12. [Pennsylvania Insert Corporation.](#)
 13. [Quazite: Hubbell Power Systems, Inc.](#)
 14. [Rinker Group, Ltd.](#)
 15. [Riverton Concrete Products.](#)
 16. [Underground Devices, Inc.](#)
 17. [Utility Concrete Products, LLC.](#)
 18. [Utility Vault Co.](#)
 19. [Wausau Tile Inc.](#)
- C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 2. Cover Legend: Cast in. Selected to suit system.

- a. Legend: "ELECTRIC".
 - 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
 - b. Seal joints watertight using preformed plastic or rubber complying with ASTM C 990. Install sealing material according to sealant manufacturers' written instructions.
 - D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
 - E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.
 - 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
 - F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
 - G. Ground Rod Sleeve: 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.
 - H. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
 - 1. Stanchions: T-section or channel with provisions to connect to other sections or channels to form a continuous unit; 1-1/2 inches in width by nominal 24 inches long; punched with 14 hook holes on 1-1/2-inch centers for cable-arm attachment.
 - 2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 - 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
 - I. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.
- 2.8 SOURCE QUALITY CONTROL
- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
 - B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by KSU Engineer.

Spec writer note: Verify architect is using 311000.

- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Cables More Than 600 V: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- C. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.
- D. Bored Underground Duct: Type EPEC-80-HDPE unless otherwise indicated.
- E. Underground Ducts Crossing Paved Paths Walks and Driveways Roadways and Railroads: Type EPC-40 PVC RNC, encased in reinforced concrete.
- F. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:

1. Units in sidewalks, Roadways and Other Deliberate Traffic Paths: Not permitted.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths not permitted.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
 1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to

environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

- G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 8 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.
- I. Building Wall Penetrations: Make a transition from underground duct to suitable raceway with the building wall, without reducing duct line slope away from the building and without forming a trap in the line.
- J. Sealing: Refer to 260544, Sleeves and Sleeve Seals for Electrical Raceways and Cabling
- K. Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.
- L. Concrete-Encased Ducts and Duct Bank:
 - 1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
 - 2. Width: Excavate trench 12 inches wider than duct on each side.
 - 3. Width: Excavate trench 3 inches wider than duct on each side.
 - 4. Depth: Install so top of duct envelope is at least 36 inches below finished grade.
 - 5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - 6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than fivespacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

7. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 12 inches between power and communications ducts.
 8. Elbows: Use manufactured schedule 80 PVC duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
 9. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 10. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 11. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 12 inches between power and communications ducts.
 12. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
 13. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
- M. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed limestone, graded from 1-inch sieve (57 stone) and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: Set frames flush with finished grade.
3. Handhole Covers: Set surface flush with finished grade. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

D. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing." After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.**E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.****F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.****G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.****3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE**

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed limestone 57 stone, graded and compacted to same density as adjacent undisturbed earth, minimum 12" deep with additional 6" within handhole.

3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

PART 4 - KSU Design Requirements

- 4.1 The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. Ductbanks: Quantity of ducts in any ductbank is variable. Refer to KSU Standard details.
 - 2. All buried cables and wiring of any type will be in conduit. Direct buried cables are prohibited. All underground medium voltage cabling will be in conduit which is encased within a steel reinforced concrete ductbank.
 - 3. All street lighting raceways, where possible, will be run parallel to curbs and walkways installed 24" from inner curb and 6" from edge of walkway.
 - 4. Medium voltage and electrical service conduit ductbanks shall be 36" from the top of ductbank to finished grade.
 - 5. Street lighting circuit conduits shall be 24" from top of conduit to finished grade.
 - 6. All ductbanks shall be sloped away from buildings and equipment and towards manholes.

7. Where medium to larger conduit(s) enters a building link-seals shall be used between the conduit and the building structure. Some type of inner conduit seal such as the Ray-Chem inflate-a-seal around the cables shall be provided.
8. Where small conduits enter the building a transition, pullbox or other break point shall be provided to prevent water entering the building.
9. Conduits shall not be located within 6' of a buried steam line.
10. Ducts for all new medium voltage ductbanks shall be minimum 5" sch40 PVC with end bell fittings at the end of each run.
11. The access into the tunnels should be a 30" x 30" aluminum Bilco door. The lockset should be keyed to match KSU master mechanical lock. A weather-tight pipe thread plug must be provided to cover and protect the lock from damage.
12. Manholes shall have a sump, grounding provisions, pulling irons and embedded anchors on all walls for future cable supports.
13. In-Ground Pull Box (Large Handholes) are to be used as needed only for teledata cabling and for conductors 600v or below where conductors are buried 36" BFG. These handholes shall be a corrosion resistant concrete/polymer blend. The boxes shall be stacked two high and be sized 36" x 48" with a concrete collar around the perimeter of the box. This concrete collar will extend 24" out from the box be 18" deep and slope away from the box. Covers will be bolt-on heavy duty type engraved "Electric" or "Teledata". Consult KSU engineer before selecting this type of handhole.
14. In-Ground pullbox (small) are to be used for street lighting circuits (at every pole), for communication cabling run to stand alone equipment such as emergency phones, ATM machines etc. These boxes will be corrosion resistant concrete/polymer blend with heavy-duty bolt-on covers, engraved "Electric" or "Teledata". There will be separate Pullboxes for communications and power conductors (campus phones, ATM machines, etc.). Max distance between teledata pullboxes is 250', refer to NEC for spacing of pullboxes for power conductors.
15. Consider providing G.P.S. positions with samples taken every 6' for all new underground pathways and utilities – provide depth dimensions as well as X & Y coordinates.
16. EC shall provide pictures of each side of a manhole or pullbox with each cable identified.
17. The duct configuration shall be symmetrical and should include a minimum of 25-50% spare ducts.
18. A ½" sch40 PVC conduit with an insulated #12 cu wire shall be run with the ductbank to enable accurate locating of ductbank. The wire shall extend into manholes and buildings and be tagged ("locator wire"). The #12 AWG wire should be fastened to concrete structure at both ends, but not connected to or touching anything metallic
19. The duct banks are to be constructed using Carlon spacers, #4 rebar continuous at all four corners with #3 rebar ties across the top and sides at 2' intervals. All duct banks must be encased in ODOT Class F concrete with 3" minimum coverage over all ducts, rebar and supports. Where duct banks cross streets upgrade the concrete two ODOT Classification Levels. EC shall have KSU engineer inspect ductbank prior to concrete pour. E.C. shall take pictures of ductbank construction process in order to show the electrical inspector.
20. The top 1" of the concrete must have red dye thoroughly raked into it when poured.
21. Tunnel – Electrical Requirements
22. Upon Completion of new underground pathways consider having a surveyor provide G.P.S. positions with samples taken every 6 feet for all new underground pathways and utilities – provide depth dimensions as well as X & Y coordinates. Provide a CD with an AutoCAD DXF file so that these changes can be imported into the KSU Campus Map using the world coordinate system.
23. Do not include any embedded conduits in tunnel walls, floors or ceilings.

24. Lighting in all utility areas and tunnels are to be Vaportight: All conduits in the tunnels shall be PVC. Adequate anchoring and expansion joints must be provided to prevent failure of support system.
25. GFCI protected “weatherproof while in use” electrical outlets must be provided every 50 ft. and feed them from a separate minimum size load center with breaker placed every 200 ft. within the tunnel
26. All tunnel lighting shall be connected and controlled by the B.A.C.C. (via. Johnson Control System). Lighting shall be 20 – 30 foot candles using 4’ LED vaportight, wet location, single electronic driver, high impact lens fixtures.
27. Separate Chalfant cable trays for High Voltage electrical feeds and teledata cabling should be installed in all tunnels. Where duct banks enter any tunnel the walls, ceiling and possible floor surfaces must be expanded an additional 18” beyond the original walls, ceiling and floor locations in order to provide for transitional piping, valves and wiring. All ductbanks must be pinned using #3 rebar (a minimum of 6” in each side) between the ductbank and the tunnel walls, floor and ceiling. All conduit penetrations shall utilize Linkseal conduit sealing systems for the conduit to wall seal and inflatable conduit sealing bags for the inside of the conduit.
28. Whenever medium voltage armored cables transition/splice to single conductor cables from cable tray to ductbank in tunnel wall, a piece of sch 40 PVC conduit shall be sleeved over the single conductor from the splice point to the tunnel wall.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

- B. Related Requirements:

- 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:

- 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

- C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Advance Products & Systems, Inc.](#)
 - b. [CALPICO, Inc.](#)
 - c. [Metraflex Company \(The\).](#)
 - d. [Pipeline Seal and Insulator, Inc.](#)
 - e. [Proco Products, Inc.](#)
 - f. GPT, Link-Seal
 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Carbon steel.
 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

- a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- C. Dedicated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

- E. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on white field.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - 1. Color shall be factory applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - 3. Colors for 240-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - 4. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: White.
 - 5. Color for Equipment Grounds: Green.
 - 6. Colors for Isolated Grounds: Green with white stripe.
- C. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.

- D. Warning labels and signs shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
- E. Equipment Identification Labels:
1. Black letters on a white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Champion America.
 - c. emedco.
 - d. Grafoplast Wire Markers.
 - e. HellermannTyton.
 - f. LEM Products Inc.
 - g. Marking Services, Inc.
 - h. Panduit Corp.
 - i. Seton Identification Products.
- B. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A'n D Cable Products.
 - b. Brady Corporation.
 - c. Brother International Corporation.
 - d. emedco.
 - e. Grafoplast Wire Markers.
 - f. Ideal Industries, Inc.
 - g. LEM Products Inc.
 - h. Marking Services, Inc.
 - i. Panduit Corp.
 - j. Seton Identification Products.
 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.

3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A'n D Cable Products.
 - b. Brady Corporation.
 - c. Brother International Corporation.
 - d. emedco.
 - e. Grafoplast Wire Markers.
 - f. HellermannTyton.
 - g. Ideal Industries, Inc.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Panduit Corp.
 - k. Seton Identification Products.
 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlton Industries, LP.
 - b. Champion America.
 - c. HellermannTyton.
 - d. Ideal Industries, Inc.
 - e. Marking Services, Inc.
 - f. Panduit Corp.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.

- c. [emedco.](#)
 - d. [Marking Services, Inc.](#)
- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [HellermannTyton.](#)
 - b. [LEM Products Inc.](#)
 - c. [Marking Services, Inc.](#)
 - d. [Seton Identification Products.](#)
- D. Underground-Line Warning Tape:
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Brady Corporation.](#)
 - b. [Ideal Industries, Inc.](#)
 - c. [LEM Products Inc.](#)
 - d. [Marking Services, Inc.](#)
 - e. [Reef Industries, Inc.](#)
 - f. [Seton Identification Products.](#)
 - 2. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 3. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE" .
 - 4. Tag: All maker tape shall be:
 - a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.

- c. Overall Thickness: 8 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Weight: 34 lb/1000 sq. ft..
 - f. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 TAGS

- A. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.
 - d. Grafoplast Wire Markers.
 - e. LEM Products Inc.
 - f. Marking Services, Inc.
 - g. Panduit Corp.
 - h. Seton Identification Products.

2.6 SIGNS

- A. Baked-Enamel Signs:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlton Industries, LP.
 - b. Champion America.
 - c. emedco.
 - d. Marking Services, Inc.
 - 2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 3. 1/4-inch grommets in corners for mounting.
 - 4. Nominal Size: 7 by 10 inches.
- B. Laminated Acrylic or Melamine Plastic Signs:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.

- b. [Carlton Industries, LP.](#)
 - c. [emedco.](#)
 - d. [Marking Services, Inc.](#)
- 2. Engraved legend.
 - 3. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - 1. [HellermannTyton.](#)
 - 2. [Ideal Industries, Inc.](#)
 - 3. [Marking Services, Inc.](#)
 - 4. [Panduit Corp.](#)
- B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer, load shedding, etc.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
 2. "POWER."
 3. "UPS."
 4. <Insert name>.
- M. Vinyl Wraparound Labels:
1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- Q. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- R. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- U. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
 2. Limit use of underground-line warning tape to direct-buried cables.

3. Install underground-line warning tape for direct-buried cables and cables in raceways.

V. Metal Tags:

1. Secure using plenum-rated cable ties.

W. Nonmetallic Preprinted Tags:

1. Secure using plenum-rated cable ties.

X. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

Y. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

Z. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch-high, black letters on 20-inch centers.
 1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals.
- D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels.
 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

- E. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- J. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- K. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- M. Arc Flash Warning Labeling: Self-adhesive labels. Secure on all:
 - a. Panelboards
 - b. Switchboards
 - c. Switchgear
 - d. Transformers
 - e. Substations
 - f. Motor-control centers
- N. Operating Instruction Signs: Self-adhesive labels.

- O. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- P. Equipment Identification Labels:
 - 1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 - 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Substations.
 - h. Emergency system boxes and enclosures.
 - i. Motor-control centers.
 - j. Enclosed switches.
 - k. Enclosed circuit breakers.
 - l. Enclosed controllers.
 - m. Variable-speed controllers.
 - n. Push-button stations.
 - o. Power-transfer equipment.
 - p. Contactors.
 - q. Remote-controlled switches, dimmer modules, and control devices.
 - r. Battery-inverter units.
 - s. Battery racks.
 - t. Power-generating units.
 - u. Monitoring and control equipment.
 - v. UPS equipment.

END OF SECTION 260553

SECTION 260573 – ELECTRICAL SYSTEM STUDIES

****THIS SECTION IS PROVIDED FOR INFORMATIONAL PURPOSES ONLY.**

****KSU STANDARD IS TO HAVE A THE ELECTRICAL SYSTEMS STUDY PERFORMED BY ONE OF THE APPROVED CONSULTANTS AND PAID FOR BY AN ALLOWANCE WITHIN IN THE ONWER'S OVERALL PROJECT BUDGET. THEREFORE THESE SPECS ARE NOT INTENDED TO BE INCLUDED IN THE BID DOCUMENTS. IF THE OWNER DOES NOT INCLUDE AN ALLOWANCE IN THE PROJECT FOR THE ELECTRICAL SYSTEM STUDY THEN THIS SPEC SECTION SHALL BE EDITED AS REQUIRED. VERIFY WITH THE KSU ENGINEER IF ALOWANCE IS INCLUDED IN PROJECT BUDGET.****

PART 1 – SERVICES PROVIDED

1.01 POWER SYSTEM STUDIES


- A. Scope of Study: Determine the short-circuit current available. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the subject system.
- B. The Study will be performed by a consultant selected by the University. Their fees will be paid by the University utilizing the “System Study Allowance” see section 012100. The consultant is responsible for hiring a contractor to collect the data. Consultant shall also coordinate with the electrical contractor to verify the electrical system data (wire size, fuse sizes, breaker sizes, cable length...) as part of the base bid work. Any changes or adjustments to fuses and or trip settings that are required as a result of the study will be the responsibility of the electrical contractor as part of the base bid work. The installation of the Arc Flash Labels will also be the responsibility of the consultant as part of the base bid work.
- C. Procedure: The short-circuit study shall be performed in accordance with the recommended practices and procedures set forth in ANSI/IEEE standard 399 and the step-by-step procedures outlined in the short-circuit calculation chapters of IEEE standard 141 and ANSI/IEEE standard 242.
- C. Study Report: Results of the short-circuit study shall be summarized in a final report containing the following items:
 - 1. Basis, description, purpose and scope of the study.
 - 2. Listing of all equipment electrical equipment including rating (voltage, power, ampacity, short circuit rating, impedance) along with building room number.
 - 3. Tabulations of the data used to model the system components and a corresponding one-line diagram.
 - 4. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate equipment short-circuit ratings.
 - 5. Tabulations of equipment short-circuit ratings versus available fault duties. The tabulation shall identify percentages of rated short-circuit and clearly note equipment with insufficient ratings.
 - 6. Conclusions and recommendations.

1.02 COORDINATION STUDIES


- A. Scope of Study: Determine protective device characteristics settings which provide a balance between equipment protection and selective device operation that is optimum for the electrical system. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the subject system.
- B. Procedure: The coordination study shall be performed in accordance with the recommended practices and procedures set forth in ANSI/IEEE standard 399 and ANSI/IEEE standard 242. Protective device selection and settings shall comply with requirements of the *National Electric Code*.
- C. Study Report: Results of the coordination study shall be summarized in a final report containing the following items:
 - 1. Basis, description, purpose and scope of the study and a corresponding one-line diagram.
 - 2. Time-current curves demonstrating the coordination of time-over-current protective devices.
 - 3. Tabulations of protective devices identifying circuit location, manufacturer, type, range of adjustment, IEEE device number, current transformer ratios, recommended settings or device size and referenced time-current current curve.
 - 4. Conclusions and recommendations.

1.03 ARC FLASH EVALUATION

- A. Provide an Arc Flash Hazard Study for the electrical distribution system shown on the one line drawings. The intent of the Arc Flash Hazard Study is to determine hazards that exist at each major piece of electrical equipment shown on the one line drawing. This includes switchgear, switchboards, panelboards, motor control centers, PDUs, UPS, ATs, and transformers. The study will include creation of Arc Flash Hazard Warning Labels. These labels serve as a guide to assist technicians and others in the selection of proper Personal Protective Equipment when working around exposed and energized conductors. The electrical contractor will install the labels.

		WARNING	
Arc Flash and Shock Hazard Appropriate PPE Required			
7'-0"	Flash Hazard Boundary		
5	Cal/cm2 Incident Energy at 1'-6"		
4160	Volts Shock Hazard When Cover is Removed		
5'-0"	Limited Approach Boundary		
2'-2"	Restricted Approach Boundary		
0'-7"	Prohibited Approach Boundary		
	Device ID:		
	TWIN TOWERS SWITCH		
	-		
	Analysis Date: 09.25.13		TRT VAULT

Example of Arc Flash Warning Label (where incident energy is 40cal/cm² or less)

		DANGER	
Arc Flash and Shock Hazard			
Interaction Prohibited When Energized			
65'-0"	Flash Hazard Boundary		
300	Cal/cm2 Incident Energy at 1'-6"		
480	Volts Shock Hazard When Cover is Removed		
3'-6"	Limited Approach Boundary		
1'-0"	Restricted Approach Boundary		
0'-1"	Prohibited Approach Boundary		
	Device ID:		
	MSB MAIN		
	-		
	Analysis Date: 09.25.13		MSB MAIN

Example of Arc Flash Danger Label (where incident energy is greater than 40cal/cm²)

- A. The arc flash hazard study shall include the electrical distribution system equipment shown on the one line drawing. If an existing up-to-date current short-circuit and protective device coordination study is not available, perform a short circuit and protective device coordination study for the electrical distribution system before performing the Arc Flash Hazard Study. The arc flash hazard study shall consider operation during normal conditions alternate operations, emergency power conditions, and any other operations, which could result in maximum arc flash hazard.

PART 2 - QUALIFICATIONS

- 2.01 The Contractor shall have the study prepared by qualified engineers of an independent consultant. The consultant shall be a Registered Professional Electrical Engineer (licensed in the state where the project is completed) who has at least ten (10) years of experience and specializes in performing power system studies.
- 2.02 The arc flash hazard study shall be performed using Easy Power for Windows computer software packages with unlimited buses. No substitutions. The base model will be provided by KSU.
- 2.03 Pre-approved:
 - A. PTA Engineering – Brian Makan (330) 666-3702
 - B. Pisal Tech LLC – Don Satayathum (330) 554-8385
 - C. Thorson Baker & Associate – Jeff Miterko (330) 659-6688
 - D. Other proposed consultants or engineers must be approved with KSU prior to submitting for bid.

PART 3 - SUBMITTALS

- 3.01 The contractor shall submit the arc flash hazard study and arc flash warning labels at least 30 days prior to energizing the electrical equipment.
- 3.02 Preliminary submittal shall be submitted to KSU Engineer for approval prior to proceeding with final submittal. KSU will have 30 days to review preliminary submittal. Upon KSU approval consultant shall proceed with the final submittal. Preliminary submittal shall consist of the following:
 - A. (1) copy of the power systems study preliminary report
 - B. An electronic copy

C. Recommendations to reduce the energy levels including recommended breaker settings.

3.03 Final submittal shall be the following:

- A. (3) copies of the power systems study final report
- B. An electronic copy
- C. (1) set of warning labels (installed in the correct location on each piece of equipment)
- D. Updated KSU EasyPower Model

PART 4 - EXECUTION

4.01 DATA COLLECTION

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on one-line diagram on Drawings. Call discrepancies to Architect's attention.
 - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers. This technician shall be provided by this sub consultant at their expense.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance or available short circuit current at the service.
 - 3. Power sources and ties.
 - 4. Short-circuit current at each system bus (three phase and line to ground).
 - 5. Full-load current of all loads.
 - 6. Voltage level at each bus.
 - 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - 8. For reactors, provide manufacturer and model designation, voltage rating and impedance.

9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

4.02 SHORT CIRCUIT STUDY

- A. Provide a current up-to-date short circuit study.

4.03 PROTECTIVE DEVICE COORDINATION STUDY

- A. Provide a current up-to-date protective device coordination study.

4.04 ARC FLASH HAZARD STUDY

- A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed.
 1. The study shall be calculated by means of the Easy Power for Windows computer software package. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.
 2. The study shall be in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S and IEEE 1584 Standards.
 3. 208V devices downstream from transformers less than 125kVA shall be excluded from the study but shall still be included on the one-line diagram. Furnish and install a general warning label on these devices.
- B. Determine the following
 1. Flash Hazard Protection Boundary
 2. Limited Approach Boundary
 3. Restricted Boundary

4. Prohibited Boundary
 5. Incident Energy Level
- C. Produce an Arc Flash Warning label listing items 1 – 5 above. Also include the bus name, voltage and drawing number. Labels shall be printed in color and be printed on adhesive backed Avery Labels. See example above.
- D. Produce Bus Detail sheets that lists the items B 1-5 from above and the Following additional items:
1. Bus Name
 2. Upstream Protective Device Name, Type, and Settings
 3. Bus Line to Line Voltage
- E. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:
1. Bus Name
 2. Upstream Protective Device Name, Type, and Settings
 3. Bus Line to Line Voltage
 4. Bus Bolted Fault
 5. Protective Device Bolted Fault Current
 6. Arcing Fault Current
 7. Protective Device Trip / Delay Time
 8. Breaker Opening Time
 9. Solidly Grounded Column
 10. Equipment Type
 11. Gap
 12. Arc Flash Boundary
 13. Working Distance
 14. Incident Energy

PART 5 - ANALYSIS

- 5.01 Analyze the short circuit, protective device coordination, and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation. Propose approaches to reduce the energy levels. Proposed major corrective modifications will be taken under advisement by the Engineer, and the Contractor will be given further instructions.

PART 6 - REPORT

- 6.01 Preliminary Report - Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed.
- A. The results of the power system study shall be summarized in a final report. The report shall include the following sections:
1. Introduction, executive summary and recommendations, assumptions, reduced copy of the one line drawing.
 2. Arc Flash Evaluations Summary Spreadsheet
 3. Bus Detail Sheets
 4. Analysis of the short circuit, protective device coordination and arc flash calculations with recommendations to reduce energy levels.
 5. Sample of proposed label (either electronic or one printed)
- 6.02 Final Report - Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed.
- A. The results of the power system study shall be summarized in a final report. The report shall include the following sections:
1. Introduction, executive summary and recommendations, assumptions, reduced copy of the one line drawing.
 2. Arc Flash Evaluations Summary Spreadsheet
 3. Bus Detail Sheets
 4. Arc Flash Hazard Warning Labels printed in color on adhesive backed labels.

END OF SECTION 260573

SECTION 260573.13 - SHORT-CIRCUIT STUDIES**TIPS:**

The Study will be performed by a Power Systems Analysis Specialist selected by the University. Their fees will be paid by the University project funds utilizing the "System Study Allowance" see section 012100. The Power Systems Analysis Specialist is responsible for hiring a contractor to collect the data on existing equipment necessary for building studies. Consultant shall also coordinate with the electrical contractor to verify the new electrical system data (wire size, fuse sizes, breaker sizes, cable length...). Any changes or adjustments to fuses and or trip settings that are required as a result of the study will be the responsibility of the electrical contractor. The installation of the Arc Flash Labels will be the responsibility of the Power Systems Analysis Specialist with assistance by electrical contractor.

PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- G. SCCR: Short-circuit current rating.

- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See "One-Line Diagram."

1.4 SUBMITTALS

- A. Product Data:
 - 1. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - a. Short-circuit study input data, including completed computer program input data sheets.
 - b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - 1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
 - 2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 - 2. The following are from the Short-Circuit Study Report:
 - a. Final one-line diagram.
 - b. Final Short-Circuit Study Report.
 - c. Short-circuit study data files.
 - d. Power system data.
 - e. Easypower Model

1.6 QUALITY ASSURANCE

- A. Study shall be performed using Easypower Software (compatible version with Kent State University).
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.

- D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- F. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. EasyPower.
- B. Comply with IEEE 399 and IEEE 551.
 - 1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - 6. Derating factors and environmental conditions.
 - 7. Any revisions to electrical equipment required by the study.
- D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.

- c. Fault-point X/R ratio.
- d. No AC Decrement (NACD) ratio.
- e. Equivalent impedance.
- f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
- g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
 - 1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
 - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of submittals for this Project.
 - 3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.
- B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
 - 1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance at the service.
 - 3. Power sources and ties.
 - 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - 5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 - 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 - 7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 - 8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 - 9. Motor horsepower and NEMA MG 1 code letter designation.
 - 10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- I. Include in the report identification of any protective device applied outside its capacity.

PART 4 - KSU Design Requirements

- A. Scope of Study: Determine the short-circuit current available. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the subject system.
- B. The Study will be performed by a consultant selected by the University. Their fees will be paid by the University utilizing the "System Study Allowance" see section 012100. The consultant is responsible for hiring a contractor to collect the data. Consultant shall also coordinate with the electrical contractor to verify the electrical system data (wire size, fuse sizes, breaker sizes, cable length...) as part of the base bid work. Any changes or adjustments to fuses and or trip settings that are required as a result of the study will be the responsibility of the electrical contractor as part of the base bid work. The installation of the

Arc Flash Labels will also be the responsibility of the consultant as part of the base bid work.

- C. Procedure: The short-circuit study shall be performed in accordance with the recommended practices and procedures set forth in ANSI/IEEE standard 399 and the step-by-step procedures outlined in the short-circuit calculation chapters of IEEE standard 141 and ANSI/IEEE standard 242.
- D. Study Report: Results of the short-circuit study shall be summarized in a final report containing the following items:
 - 1. Basis, description, purpose and scope of the study.
 - 2. Listing of all equipment electrical equipment including rating (voltage, power, ampacity, short circuit rating, impedance) along with building room number.
 - 3. Tabulations of the data used to model the system components and a corresponding one-line diagram.
 - 4. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate equipment short-circuit ratings.
 - 5. Tabulations of equipment short-circuit ratings versus available fault duties. The tabulation shall identify percentages of rated short-circuit and clearly note equipment with insufficient ratings.
 - 6. Conclusions and recommendations.

END OF SECTION 260573.13

SECTION 260573.16 - COORDINATION STUDIES

Tips:

The Study will be performed by a Power Systems Analysis Specialist selected by the University. Their fees will be paid by the University project funds utilizing the “System Study Allowance” see section 012100. The Power Systems Analysis Specialist is responsible for hiring a contractor to collect the data on existing equipment necessary for building studies. Consultant shall also coordinate with the electrical contractor to verify the new electrical system data (wire size, fuse sizes, breaker sizes, cable length...). Any changes or adjustments to fuses and or trip settings that are required as a result of the study will be the responsibility of the electrical contractor. The installation of the Arc Flash Labels will be the responsibility of the Power Systems Analysis Specialist with assistance by electrical contractor.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

- 1. Study results shall be used to determine coordination of series-rated devices.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

- E. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- G. SCCR: Short-circuit current rating.
- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See "One-Line Diagram."

1.4 SUBMITTALS

- A. Product Data
 - 1. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - a. Coordination-study input data, including completed computer program input data sheets.
 - b. Study and equipment evaluation reports.
 - 2. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 - 1. The following are from the Coordination Study Report:
 - a. Final one-line diagram.
 - b. Final protective device coordination study.
 - c. Coordination study data files.
 - d. List of all protective device settings.
 - e. Time-current coordination curves.
 - f. Power system data.
 - g. Easypower Model

1.6 QUALITY ASSURANCE

- A. Studies shall be performed using Easypower Software(compatible version with Kent State University).
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications:
 - 1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. EasyPower.
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:

- a. Arcing faults.
- b. Simultaneous faults.
- c. Explicit negative sequence.
- d. Mutual coupling in zero sequence.

2.2 COORDINATION STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
 - 6. Any revisions to electrical equipment required by the study.
 - 7. Study Input Data: As described in "Power System Data" Article.
 - a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- D. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, and ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists

between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.
- B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Electrical power utility impedance at the service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus (three phase and line to ground).
 5. Full-load current of all loads.
 6. Voltage level at each bus.
 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 12. Maximum demands from service meters.
 13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
 14. Motor horsepower and NEMA MG 1 code letter designation.
 15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
 16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
 17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

- c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
- d. Generator thermal-damage curve.
- e. Ratings, types, and settings of utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
- k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

- c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
 - H. Motor Protection:
 - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
 - I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
 - J. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.
 - K. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.
 - L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
 - M. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
 - 3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
 - 4. Include in the report identification of any protective device applied outside its capacity.
- 3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY
- A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:
 - 1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
 - 2. Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.

3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 MOTOR-STARTING STUDY

- A. Perform a motor-starting study to analyze the transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of motor starting on the power system stability.
- B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141 and voltage sags so as not to affect operation of other utilization equipment on system supplying the motor.

3.6 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

PART 4 - KSU Design Requirements

- A. Scope of Study: Determine protective device characteristics settings which provide a balance between equipment protection and selective device operation that is optimum for the electrical system. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the subject system.
- B. Procedure: The coordination study shall be performed in accordance with the recommended practices and procedures set forth in ANSI/IEEE standard 399 and ANSI/IEEE standard 242. Protective device selection and settings shall comply with requirements of the *National Electric Code*.
- C. Study Report: Results of the coordination study shall be summarized in a final report containing the following items:

1. Basis, description, purpose and scope of the study and a corresponding one-line diagram.
2. Time-current curves demonstrating the coordination of time-over-current protective devices.
3. Tabulations of protective devices identifying circuit location, manufacturer, type, range of adjustment, IEEE device number, current transformer ratios, recommended settings or device size and referenced time-current current curve.
4. Conclusions and recommendations.

END OF SECTION 260573.16

SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS

Tips:

The Study will be performed by a Power Systems Analysis Specialist selected by the University. Their fees will be paid by the University project funds utilizing the "System Study Allowance" see section 012100. The Power Systems Analysis Specialist is responsible for hiring a contractor to collect the data on existing equipment necessary for building studies. Consultant shall also coordinate with the electrical contractor to verify the new electrical system data (wire size, fuse sizes, breaker sizes, cable length...). Any changes or adjustments to fuses and or trip settings that are required as a result of the study will be the responsibility of the electrical contractor. The installation of the Arc Flash Labels will be the responsibility of the Power Systems Analysis Specialist with assistance by electrical contractor.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

- G. SCCR: Short-circuit current rating.
- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See "One-Line Diagram."

1.4 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals may be in digital form:
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
 - 3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power Systems Analysis Software Developer.
 - 2. For Power System Analysis Specialist.
 - 3. For Field Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
 - 2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. EasyPower.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT



- A. Executive summary of study findings.

- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- G. Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Restricted approach boundary.
 - 6. Limited approach boundary.
 - 7. Working distance.
 - 8. Incident energy.
 - 9. Hazard risk category.
 - 10. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
- B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
1. Location designation.
 2. Nominal voltage.
 3. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
 4. Arc flash PPE category.
 5. Required minimum arc rating of PPE in Cal/cm squared.
 6. Available incident energy.
 7. Working distance.
 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

D. Label Examples:

 WARNING				 DANGER			
Arc Flash and Shock Hazard Appropriate PPE Required				Arc Flash and Shock Hazard Interaction Prohibited When Energized			
7'-0"	Flash Hazard Boundary			65'-0"	Flash Hazard Boundary		
5	Cal/cm2 Incident Energy at 1'-6"			300	Cal/cm2 Incident Energy at 1'-6"		
4160	Volts Shock Hazard When Cover is Removed			480	Volts Shock Hazard When Cover is Removed		
5'-0"	Limited Approach Boundary			3'-6"	Limited Approach Boundary		
2'-2"	Restricted Approach Boundary			1'-0"	Restricted Approach Boundary		
0'-7"	Prohibited Approach Boundary			0'-1"	Prohibited Approach Boundary		
Device ID: TWIN TOWERS SWITCH				Device ID: MSB MAIN			
-				-			
Analysis Date: 09.25.13 TRT VAULT				Analysis Date: 09.25.13 MSB MAIN			

1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis or obtain results from another source.
 - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
 - 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
 - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
 - 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
 - 4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.
- D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.
- F. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.

- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
 1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

- A. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
 - 1. Motor-control center.
 - 2. Low-voltage switchboard.
 - 3. Switchgear.
 - 4. Medium-voltage switch.
 - 5. Medium voltage transformers
 - 6. Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.
 - 7. Panelboard and safety switch over 250 V.
 - 8. Applicable panelboard and safety switch under 250 V.
 - 9. Control panel.
 - 10. Motor controllers (starters and variable frequency drives).
 - 11. Disconnect and safety switches.
- C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.
 - 1. Indicate arc-flash energy.
 - 2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

PART 4 - KSU Design Requirements

- A. Provide an Arc Flash Hazard Study for the electrical distribution system shown on the one line drawings. The intent of the Arc Flash Hazard Study is to determine hazards that exist at each major piece of electrical equipment shown on the one line drawing. This includes switchgear, switchboards, panelboards, motor control centers, PDUs, UPS, ATSSs, and transformers. The study will include creation of Arc Flash Hazard Warning Labels. These labels serve as a guide to assist technicians and others in the selection of proper Personal Protective Equipment when working around exposed and energized conductors. The electrical contractor will install the labels.

END OF SECTION 260573.19

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching and dimming controls.
4. Indoor occupancy and vacancy sensors.
5. Switchbox-mounted occupancy sensors.
6. Digital timer light switches.
7. High-bay occupancy sensors.
8. Extreme temperature occupancy sensors.
9. Outdoor motion sensors.
10. Lighting contactors.
11. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
 - c. Daylight sensors
 - d. Motion sensors
 - e. Lighting contactors
 - f. Emergency shunt relays
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT DOCUMENTS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.
 - 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Industries, Inc.
 - 2. Intermatic, Inc.
 - 3. Invensys Controls.
 - 4. Leviton Manufacturing Co., Inc.
 - 5. NSi Industries LLC.
 - 6. TE Connectivity Ltd.
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
 - 2. Contact Configuration: SPST.
 - 3. Contact Rating: 30-A inductive or resistive, 240-V ac.
 - 4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
 - 5. Astronomic Time: All channels.
 - 6. Automatic daylight savings time changeover.
 - 7. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. NSi Industries LLC.
 5. TE Connectivity Ltd.
 6. Wattstopper.
- B. Description: Solid state, with SPST dry contacts rated for 1000W resistive to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
- C. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
- E. Time Delay: Fifteen-second minimum, to prevent false operation.
- F. Surge Protection: Metal-oxide varistor.
- G. Failure Mode: Luminaire stays ON.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Leviton Manufacturing Co., Inc.
 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 4. WattStopper; a Legrand® Group brand.
- B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.

- b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
 - 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
- E. Power Pack: Digital controller capable of accepting 3 RJ45 inputs with one outputs rated for 20A incandescent LED load at 120 and 277V ac, for 16A LED at 120 and 277V ac, and for 1 hp at 120V ac. Sensor has 24V dc Class 2 power source, as defined by NFPA 70.
 - 1. Compatible with digital addressable lighting interface.
 - 2. Plenum rated.

2.4 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Industries, Inc.
 - 2. Leviton Manufacturing Co., Inc.
 - 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 4. Lutron Electronics Co., Inc.
 - 5. Sensor Switch, Inc.
 - 6. WattStopper; a Legrand® Group brand.
- B. General Requirements for Sensors:
 - 1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 - 2. Passive infrared, Ultrasonic, or Dual technology.
 - 3. Separate power pack.
 - 4. Hardwired and Wireless connection to switch power pack.
 - 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

- c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
 - 8. Power Pack: Dry contacts rated for 20-A LEDload at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 9. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 10. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 11. Bypass Switch: Override the "on" function in case of sensor failure.
- C. PIR Type: Wall or Ceiling mounted; detect occupants in coverage area by their heat and movement.
- 1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
 - 2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 - 3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.
 - 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 2000 square feet when mounted 48 inches above finished floor.
- D. Ultrasonic Type: Wall or Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
- 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch-high ceiling.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 - 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.
 - 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot-high ceiling in a corridor not wider than 14 feet.
 - 6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 2000 square feet when mounted 84 inches above finished floor.

- E. Dual-Technology Type: Wall or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 2000 square feet 3000 square feet when mounted 48 inches above finished floor.

2.5 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Leviton Manufacturing Co., Inc.
 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 4. Lutron Electronics Co., Inc.
 5. Sensor Switch, Inc.
 6. WattStopper; a Legrand® Group brand.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox with provisions for connection to BAS using hardwired connection or using wireless connection.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.
 5. Refer to drawings for additional details.

2.6 HIGH-BAY OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Eaton.
 2. Hubbell Building Automation, Inc.
 3. Sensor Switch.
 4. Wattstopper.

- B. Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
 3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
 4. Power: Line voltage.
 5. Operating Ambient Conditions: 32 to 149 deg F.
 6. Mounting: Threaded pipe.
 7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 8. Detector Technology: PIR.
- C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.
- D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.7 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
 2. ASCO: a brand of Vertiv.
 3. Eaton.
 4. General Electric Company.
 5. Square D.
- B. Description: Electrically operated and electrically held, combination-type lighting contactors with fusible switch, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.8 EMERGENCY SHUNT RELAY

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Acuity Controls.
2. Bodine
3. Eaton.
4. Hubbell Control Solutions.
5. WattStopper; a Legrand® Group brand.

B. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 or 277 V match circuit voltage.

2.9 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

- A. Comply with NECA 1.
- B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.

- D. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within **12 months** from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to **four (4) visits** to Project during **12 month period** immediate following substantial completion.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train] Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. KSU prefers to control outdoor lighting via photocell to a contactor with a hand/off/auto selector switch. An astronomic time clock can be used for control of accent lighting or for lighting needing more flexible control not typically used for security lighting.
 - 2. In special cases it may be suggested that we shall utilize the Kent State University Building Automation and Control System (Johnson Controls) contacts to interface the lighting control system allowing BACC to override and/or load shed non-emergency exterior lighting.
 - 3. All contactors shall have Hand/Off/Auto selector switch – lockable in all three (3) positions.
 - 4. All indoor classroom/Auditorium lighting controls should be Lutron with compatible drivers.
 - 5. Addressable ballasts/drivers shall not be used.
 - 6. Our standard light fixtures for classroom and office spaces has become the high efficiency fixtures by Lithonia (RTLED) and Cooper (Accord series) or equal must have minimum fixture efficiency of 83%.
 - 7. Time clocks are not desired on KSU campuses. If a time clock is to be installed, it must be digital astronomic type with battery backup.
 - 8. Dual Technology Occupancy Sensors shall be used for offices and classrooms.
 - 9. Ultrasonic type occupancy sensors are used in the restroom facilities.
 - 10. Common area lighting shall have on off control either manual or automatic along with occupancy sensors throughout. Optional control with dimming drivers or step dimming

dropping light levels to 30-50% when unoccupied and 100% when occupied and auto shut-off after normal hours.

11. We use wall box timer switches for janitor's closets, storage rooms and other room types that are not typically occupied for long periods of time. We can consider use of these wall box timer switches for Mechanical rooms as long as supplemental night lights are utilized (verify with latest NEC restrictions).
12. Outdoor motion sensors are to be NEMA 3R or 4X.
13. Preferred occupancy sensor manufacturers are Lutron, Sensor Switch and Wattstopper.
14. KSU follows ASHRAE 90.1.
15. Emergency lighting is to be connected to the emergency power system. Bodine emergency drivers are an acceptable alternate if an emergency power supply is not available. All emergency fixtures shall operate a minimum of 90 minutes under their full load.
16. All 2'x4' lay in type fixtures should be supported on all four corners from the building structure. The lights are not to be supported by the suspended ceiling grid. The support wires should be installed by the Contractor installing the suspended ceiling.
17. Offices equipped with LED lights shall be dimmed to 10%.
18. Occupancy sensors shall have auxiliary set of contacts for HVAC control.

END OF SECTION 260923

SECTION 260936 - MODULAR DIMMING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wall-box, multiscene, modular dimming controls.
 - 2. Multipreset modular dimming controls.

1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
- C. Low Voltage: As defined in NFPA 70, the term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.
- D. RFI: Radio-frequency interference.
- E. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
- F. SCR: Silicon-controlled rectifier.
- G. Zone: A luminaire or group of luminaires controlled simultaneously as a single entity. Also known as a "channel."

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For modular dimming controls; include elevation, dimensions, features, characteristics, ratings, and labels.
 - 2. Device plates and plate color and material.
 - 3. Drivers compatible with dimmers.
 - 4. Operational documentation for firmware/software.

- B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
1. Include elevation views of front panels of control and indicating devices and control stations.
 2. Include diagrams for power, signal, and control wiring.
 3. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.
 4. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
 5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For standalone multipreset modular dimming controls to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manuals.
 - b. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
 - c. Operation of adjustable zone controls.
 - d. Testing and adjusting of panic and emergency power features.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of standalone multipreset modular dimming controls that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Damage from transient voltage surges.
 2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.
 3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Douglas Lighting Controls.
 2. Leviton Manufacturing Co., Inc.
 3. NLight/Acuity Wattstopper
 4. Lutron Electronics Co., Inc.

2.2 SYSTEM DESCRIPTION

- A. Compatibility:
1. Dimming control components shall be compatible with luminaires.
 2. Dimming control devices shall be compatible with lighting control system components specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls," and in Section 260923 "Lighting Control Devices."
- B. Dimmers and Dimmer Modules: Comply with UL 508.
1. Audible Noise and RFI Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or RFI. Modules shall include integral or external filters to suppress audible noise and RFI.
 2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
- C. Capacities: Unit shall be rated for 2400 W at 240-V ac and 2000 W at 120-V ac for up to 100 devices or zones.
- D. Surge Protection: Withstand supply power surges without impairment to performance.
- E. Off Control Position: User-selected off position of any control point shall disconnect the load from line supply.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WALL-BOX MULTISCENE DIMMING CONTROLS

- A. Description: Factory-fabricated equipment providing manual dimming consisting of a wall-box-mounted master controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in multigang wall box under a single wall plate. Each

zone shall be adjustable to indicated number of scenes, which shall reside in the memory of zone controller.

- B. Dimmers: Each zone shall be configurable to control the following loads:
 - 1. Switching.
 - 2. 0-10V
- C. Dimmers: Regulate voltages to maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent of rms voltage.
- D. Memory:
 - 1. Retain preset scenes through power failures for at least seven days.
- E. Device Plates: Style, material, and color shall comply with Section 262726 "Wiring Devices." Master-control cover plate shall be one piece.
- F. Master controller shall include the following:
 - 1. Cover-mounted switches, including master off, all bright, and selectors for each scene.
 - 2. Cover-mounted LED indicator lights, one associated with each scene switch, and one for the master off switch.
 - 3. Concealed switches and indicators for specified function.
 - 4. A raise/lower switch for each zone for temporary adjustments of the zone, without altering scene values stored in memory.
 - 5. Fade time indicated by digital display for current scene while fading.
 - 6. Cover-mounted infrared receiver.
 - 7. The previous features must be duplicated if system utilized is a touchscreen. Usage must be approved by KSU Engineer.

2.4 MULTIPRESET MODULAR DIMMING CONTROLS

- A. Description: Factory-fabricated equipment providing manual dimming consisting of the following:
 - 1. Master controller.
 - 2. Dimmer panels, and indicated number of zone stations.
 - 3. Controls and dimmers shall be integrated for mounting in a multigang wall box under a single wall plate.
 - 4. Each zone shall be adjustable to indicated number of scenes, which shall reside in the memory of zone controller.
- B. Dimmers: Each zone shall be configurable to control the following loads:
 - 1. Switching.
 - 2. 0-10V.
- C. Dimmers: Regulate voltages to maintain constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent of rms voltage.

- D. Memory: Retain preset scenes and fade settings through power failures by retaining physical settings of controls.
- E. Device Plates: Style, material, and color shall comply with Section 262726 "Wiring Devices." Master-control cover plate shall be one piece.
- F. Master controller shall include the following:
 - 1. Wall-box style, single coverplate supplied by manufacturer.
 - 2. Cover-mounted switches, including master off, all bright, and selectors for each scene.
 - 3. Cover-mounted LED indicator lights, one associated with each scene switch, and one for the master off switch.
 - 4. Concealed switches and indicators for specified function.
 - 5. A raise/lower switch for each zone for temporary adjustments of the zone, without altering scene values stored in memory.
 - 6. Fade time indicated by digital display for current scene while fading.
 - 7. Cover-mounted infrared receiver.
- G. Remote-Control Stations:
 - 1. Numbered push buttons to select scenes.
 - 2. Off switch to turn master station off. Operating the off switch at any remote station shall automatically turn on selected housekeeping lighting.
 - 3. On switch turns all scenes of master station to full bright.
 - 4. Control Wiring: NFPA 70, Class 2.
 - 5. Mounting: Single flush wall box with manufacturer's standard faceplate.
- H. Circuit Breakers: Complying with UL 489 and classified as switch duty.

2.5 CONDUCTORS AND CABLES

- A. Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG.
- B. For systems requiring category cable, cable shall be CMP (Plenum) Cat.5e, color: yellow, and installed per section 271513, "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Label each dimmer module with a unique designation.
- C. Label each scene control button with KSU Engineer approved scene description.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Continuity tests of circuits.
 - 2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
 - a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
- D. Dimming control components will be considered defective if they do not pass tests and inspections.
- E. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- F. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular dimming controls.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
1. General application dimming controls should be manufactured by Lutron/Grofik Eyc, wattstopper/DLM and Nlight/Acuity Fresco..
 2. 0-10V dimming is preferred for LED fixtures.
 3. Addressable ballasts/drivers should be avoided.
 4. Each room entrance shall have a wallswitch one of these shall have a multiple scene selections and should be mounted on or adjacent to teaching station if one exists.
 5. Mounting switches to teaching stations should be done utilizing Extron Electronics surface mount boxes (SMB-102-Black (2gang), SMB-103 (3gang)...).
 6. All classrooms and lecture Halls shall incorporate occupancy sensors connected to the Dimming Control System.
 7. If natural light is abundant in the room then a daylight harvesting sensor shall be installed.
 8. For larger classrooms with AV equipment the lighting scenes are typically setup as 1 – all lights on 100%, 2 – projector or overhead presentation where lights in room are dimmed down to about 50% and front row of lights are turned off, 3 – All lights set to 75%, 4- All lights set to 50%, 5 – All lights set to 20-30% and an off button.
 9. For larger classrooms with AV equipment provide AV I/O capability to connect to Extron system at teacher station.
 10. All above ceiling controls shall be installed on corridor wall near entry door(s).
 11. Dimming shall be provided in offices, open office areas, reception areas, lobby waiting areas, display areas within corridors, conference rooms and classrooms where LED lighting is used. Dimming is required in all spaces the following exceptions: maintenance rooms, tunnels, kitchens, mechanical, electrical and telecom rooms.

END OF SECTION 260936

SECTION 261216 - DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes dry-type, medium-voltage transformers, with primary and secondary bushings within or without air-terminal enclosures.

1.3 DEFINITIONS

- A. BAS: Building Automation System.
- B. BIL: Basic Impulse Insulation Level.
- C. VPI: Vacuum Pressure Impregnation.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For dry-type, medium-voltage transformers.
 - 1. Include plans and elevations showing major components and features.
 - a. Include a plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits.
 - 2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include single-line diagram.
 - 4. Include list of materials.
 - 5. Include nameplate legends.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Industries, Inc.
 - 2. Eaton.
 - 3. General Electric Company.
 - 4. Siemens Industry, Inc., Energy Management Division.
 - 5. Square D; by Schneider Electric.
 - 6. ABB

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2.
- C. Comply with IEEE C57.12.01.

2.3 PERFORMANCE REQUIREMENTS

- A. Windings Material: Copper.
- B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.
- C. Cooling Systems: Comply with IEEE C57.12.01 for cooling class. Forced air cooling shall be coordinated with KSU Engineer.
- D. Coils Insulation Systems:
 - 1. Primary and secondary coil assemblies shall be manufactured using polyester VPI system.
- E. Winding Connections: Connection of windings and terminal markings shall comply with IEEE C57.12.70.
- F. Efficiency: Comply with 10 CFR 431, Subpart K.
- G. Bushings shall comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.
- H. Tap Changer: External, for de-energized operation.

I. Enclosure:

1. Provide with provisions for lifting and anchoring frame to concrete pad.
2. With an integral skid-mounting frame, suitable to allow skidding or rolling of transformer in any direction.
3. Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.
4. Taps: Two 2-1/2-percent, full-capacity taps above and two 2-1/2-percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.

J. Sound level shall comply with requirements of NEMA TR 1.

K. Capacities and Characteristics:

1. Enclosure: Ventilated power transformer, NEMA 250 Type 1 enclosure.
2. Additional IEEE Standards: Comply with IEEE C57.12.51.
3. Comply with UL 1562 listing requirements.
4. Service Conditions: The transformers shall be suitable for operation under service conditions specified as usual service conditions in IEEE C57.12.01, except for the following:
 - a. Altitudes above 3,300 feet.
 - b. Cooling air or water temperature exceeds limits.
 - c. Excessive load current harmonic factor.
 - d. Operation above rated voltage or below rated frequency.
 - e. Exposure to fumes, vapors, or dust.
 - f. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
 - g. Exposure to excessively high or low temperatures.
 - h. Unusual transportation or storage conditions.
 - i. Unusual grounding resistance conditions.
 - j. Unusual space limitations.
5. Connections:
 - a. Primary: Air-filled terminal cabinet for cable connection.
 - b. Secondary: Throat for busway connection.
6. Transformer Ratings:
 - a. Impedance: Not less than 5.75 percent.
 - b. Temperature Rise: 115 deg C.
 - c. Coils Connection:
 - 1) High-Voltage Winding: Delta.
 - 2) Low-Voltage Winding: Wye.
 - d. Voltage and BIL Ratings:
 - 1) Nominal primary phase-to-phase voltage and BIL: 13 800 V, 60 kV.

- 2) Nominal secondary voltage and BIL: 208Y/120 V, 10 kV
480Y/277 V, 10 kV.
7. Taps: Two 2-1/2-percent, full-capacity taps above and two 2-1/2-percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.51 requirements.
8. Transformer Accessories:
 - a. Three phase digital temperature monitor with audible alarm and auxiliary contacts for future fans.
 - b. At least four stainless-steel ground connection pads.
 - c. Provisions for jacking, lifting, and towing.
 - d. Machine-engraved nameplate made of anodized aluminum or stainless steel.

2.4 WARNING LABELS AND SIGNS

- A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
 1. Warning signs shall be made of baked enamel.
 2. Equipment Identification Labels: Engraved, laminated-acrylic or -melamine label.

2.5 SOURCE QUALITY CONTROL

- A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.91.
- B. Perform the following factory-certified routine tests on each transformer 500 kVA and less for this Project:
 1. Turns ratio, polarity, and phase relation on rated voltage connection.
 2. Transformer no-load losses and excitation current at 100 percent of ratings. This test may be based on a statistical sample.
 3. Applied voltage and induced voltage.
 4. Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
 5. Temperature rise at minimum and maximum ratings.
 6. Impulse.
 7. Insulation power factor.
 8. Insulation resistance.
 9. Audible sound level.
 10. Short-circuit capability.
 11. Operation of all devices.
 12. Control (auxiliary) and consumption loss data values.
- C. Perform the following factory-certified tests on each transformer 500 kVA and larger for this Project. Reports shall comply with the minimum information requirements of IEEE C57.12.01:
 1. Resistance measurements of all windings on rated voltage tap and at tap extremes.

2. Turns ratio, polarity, and phase relation on rated voltage connection.
3. Transformer no-load losses and excitation current at 100 percent of ratings.
4. Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
5. Applied voltage and induced voltage.
6. Temperature rise at minimum and maximum ratings.
7. Impulse.
8. Insulation power factor.
9. Insulation resistance.
10. Audible sound level.
11. Short-circuit capability.
12. Operation of all devices.
13. Control (auxiliary) and consumption loss data values.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine dry-type, medium-voltage transformers upon delivery.
 1. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.
 2. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
 3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
 4. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
 5. Unload transformers carefully, observing all packing label warnings and handling instructions.
 6. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.
- B. Handling:
 1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
 2. Protect transformer against entrance of dust, rain, and snow.
 3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and transformer case.
 4. Verify that transformer weights are within rated capacity of handling equipment.
 5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.
 6. Use jacks only at corners of base plate of transformer case.

7. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.
 8. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
 9. Exercise care not to damage base structure of case when handling transformer using skids or rollers. Use skids to distribute stresses over case base when using rollers under large transformers.
- C. Storage:
1. Store transformers in accordance with manufacturer's recommendations.
 2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
 3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
 4. Store transformers with compartment doors closed.
 5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Visually check for rust spots.
- D. Examine areas and space conditions for compliance with requirements for dry-type, medium-voltage transformers and other conditions affecting performance of the Work.
- E. Examine roughing-in of conduits and grounding systems to verify the following:
1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.
- F. Examine walls, floors, roofs, and concrete bases for suitable conditions for transformer installation.
- G. Pre-Installation Checks:
1. Verify removal of any shipping bracing after placement.
- H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer location.
- I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- B. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.
- C. Comply with requirements for vibration isolation specified in Section 260529 "Hangers and Supports for Electrical Systems"
- D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than No. 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable, with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
 - 2. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.
 - 3. Complete transformer grounding and lightning arrester connections prior to making any other electrical connections.
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
 - 2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.
- C. Terminate medium-voltage cables in incoming section of substations according to Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

- A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
- B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:

- 1. General Field-Testing Requirements:

- a. Comply with provisions of NFPA 70B, Ch. "Testing and Test Methods."
- b. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
- c. After installing transformer but before primary is energized, verify that grounding system at substation is tested at specified value or less.
- d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
- e. Visual and Mechanical Inspection:
 - 1) Verify equipment nameplate data complies with Contract Documents.
 - 2) Inspect bolted electrical connections for high resistance using one of the following two methods:
 - a) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.
- f. Remove and replace malfunctioning units and retest.
- g. Prepare test and inspection reports. Record as-left set points of all adjustable devices.

- 2. Medium-Voltage Surge Arrester Field Tests:

- a. Visual and Mechanical Inspection:
 - 1) Inspect physical and mechanical condition.
 - 2) Inspect anchorage, alignment, grounding, and clearances.
 - 3) Verify arresters are clean.

- 4) Verify that ground lead on each device is individually attached to a ground bus or ground electrode.
 - 5) Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.
 - b. Electrical Test:
 - 1) Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in that table.
 - 2) Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.
3. Dry-Type Transformer Field Tests:
 - a. Visual and Mechanical Inspection:
 - 1) Inspect anchorage, alignment, and grounding.
 - 2) Verify that resilient mounts are free and that any shipping brackets have been removed.
 - 3) Verify bushings are clean.
 - 4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
 - 5) Verify that cooling fans operate correctly and have appropriate overcurrent protection.
 - 6) Perform specific inspections and mechanical tests recommended by manufacturer.
 - 7) Verify that as-left tap connections are as specified.
 - 8) Verify secondary voltage is within 2.5% of nominal secondary voltage. Adjust taps to achieve as close as possible to nominal voltage.

3.6 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each transformer. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during test period, is unacceptable.
 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Adjust transformer taps.
 - b. Prepare written request for voltage adjustment by KSU Engineer.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Report:
 - a. Prepare a written report covering monitoring performed and corrective action taken.
- B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove all necessary covers prior to inspection.
 1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
 2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°deg C at 30°deg C.
 3. Record of Infrared Inspection: Prepare a certified report that identifies testing technician and equipment used, and lists results as follows:
 - a. Description of equipment to be tested.
 - b. Discrepancies.
 - c. Temperature difference between area of concern and reference area.
 - d. Probable cause of temperature difference.
 - e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
 - f. Identify load conditions at time of inspection.
 - g. Provide photographs and thermograms of deficient area.
 4. Act on inspection results according to recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to Train Owner's maintenance personnel to adjust, operate, and maintain systems.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 1. DRY TYPE MEDIUM VOLTAGE TRANSFORMERS – INDOOR
 - a. All windings are to be copper.
 - b. Ventilated indoor type enclosure shall be ANSI 61 Gray in color.
 - c. Ground bar shall be installed length of enclosure and connect to ground bars in primary switch and secondary distribution compartments.
 - d. Transformer coils shall be of continuous wound construction and impregnated utilizing VPI Process.

- e. Fan cooling package with microprocessor based controller that will increase the capacity of the transformer by 33%. Transformer shall not be sized based on this fan cooling.
 - f. This cooling controller shall also monitor transformer temperature and provide an audible alarm and dry set of contacts for monitoring.
 - g. 4" high housekeeping pad shall extend a minimum of 4" around the transformer on all sides.
 - h. Transformer shall be designed with a 115 degree C temperature rise.
 - i. There shall be a total of 5 taps:
 - One (1) center tap
 - Two (2) +2.5% taps
 - Two (2) -2.5% taps
2. GENERAL
- a. New Building Services shall be 208Y/120V 3 phase 4 wire or 480/277V 3 phase 4 wire, where alternate voltages are required, consider the use of buck/boost transformers.

END OF SECTION 261216

SECTION 261219 - PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes pad-mounted, liquid-filled, medium-voltage distribution transformers, with primary and secondary bushings within or without air-terminal enclosures.

1.3 DEFINITIONS

- A. BIL: Basic Impulse Insulation Level.
- B. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.
- C. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."
- D. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or nonload break, separable insulated connector (bushing).
- E. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).
- F. Elbow Connector: See "bushing elbow" above.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For pad-mounted, liquid-filled, medium-voltage transformers.

1. Include plans and elevations showing major components and features.
 - a. Include a plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.
2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include single-line diagram.
4. Include list of materials.
5. Include nameplate data.
6. Manufacturer's published time-current curves of the transformer high-voltage fuses, with transformer damage curve, inrush curve, and thru fault current indicated.

1.5 CLOSEOUT DOCUMENTS

- A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.
- B. Product cutsheet for replacement primary fusing with replacement part numbers

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

Retain NFPA 70 compliance required in "Electrical Components, Devices, and Accessories" Paragraph below when the transformer is installed pursuant to conditions listed in NFPA 70 for pad-mounted, liquid-filled, medium-voltage transformers.

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2.
- C. Comply with IEEE C57.12.00.

2.2 PERFORMANCE REQUIREMENTS

- A. Windings Material: Copper.
- B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into the inserts provided in the high-voltage section of the transformer. Connected in each phase of incoming circuit and ahead of any disconnecting device.
- C. Winding Connections: The connection of windings and terminal markings shall comply with IEEE C57.12.70.

- D. Efficiency: Comply with 10 CFR 431, Subpart K.
- E. Insulation: Transformer kVA rating shall be as follows: The average winding temperature rise above a 30 deg C ambient temperature shall not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested according to IEEE C57.12.90, using combination of connections and taps that give the highest average winding temperature rise.
- F. Tap Changer: External handle, for de-energized operation.
- G. Tank: Sealed, with welded-on cover. Designed to withstand internal pressure of not less than 7 psi (50 kPa) without permanent distortion and 15 psig (104 kPa) without rupture. Comply with IEEE C57.12.36.
- H. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.
- I. Mounting: An integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.
- J. Insulating Liquids:
 - 1. Mineral Oil: ASTM D3487, Type II, and tested for compliance with ASTM D117.
- K. Sound level shall comply with NEMA TR 1 requirements.
- L. Corrosion Protection:
 - 1. Transformer coating system shall be factory applied, complying with requirements of IEEE C57.12.28, in manufacturer's standard color green on welded steel tank with stainless steel hinges.

2.3 THREE-PHASE TRANSFORMERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB.
 - 2. Cooper Industries, Inc.
 - 3. General Electric Company.
 - 4. Hammond Manufacturing.
 - 5. Howard Industries, Inc.
 - 6. Siemens ITE
 - 7. Square D by Schneider Electric.
 - 8. General Electric Co.
 - 9. Uptegraff Manufacturing Company.

2.4 PAD MOUNTED TRANSFORMERS

- A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer and as required for complete installation.
- B. In general, electrical characteristics, capacities, required taps and other features to be as shown on drawings or described elsewhere in these specifications.
- C. Transformer to include, but not be limited to, the following features:
1. Ratings:
Primary Voltage: 13,200 volt, Delta, 3-phase, 60Hz.
Secondary Voltage: 480Y/277 volt, or 208Y/120 Volt Wye. Refer to drawing.
Impedance: 5.75%
Size: 225 KVA to 1500 KVA. Refer to drawings for KVA rating.
 2. Compartment type, self-cooled, tamper proof and weatherproof for mounting on a concrete pad. Transformer enclosure shall have stainless steel hinges.
 3. Average temperature rise of winding, measured by resistance method, to be 55 degrees C when transformer is operated at rated KVA output in a 40 degrees C ambient. Transformer to be capable of being operated at rated load in a 30 degrees C average, 40 degrees C maximum ambient, as defined by ANSI C57.12.00, without loss of service life expectancy.
 4. Transformer shall be self cooled. Coolant and insulating fluid to be inhibited mineral oil unless noted otherwise on drawings.
 5. High and low voltage compartments to be located side-by-side, separated by a steel barrier with low voltage section being on the right when facing the compartment. Terminal compartments to be full height, air filled, with individual doors complete with hasp and padlock. **NOTE: Terminal compartment depth to be sufficient to permit the installation of 600A dead break elbows with 200A inserts for 200A load break lightning arresters.**
 - a. High voltage door fastenings shall not be accessible until low voltage door has been opened.
 - b. Doors to be equipped with lift-off, stainless steel hinges and door stops.
 - c. Doors to be tamperproof, served by a pentahead bolt and padlock arrangement.
 6. Coils to be wound with copper.
 7. Basic Impulse Level rating shall comply with UL 1062.
 8. Tank to be sealed type of sufficient strength to withstand a pressure of 7 psi without permanent distortion, with welded cover and tamper proof fastenings. Tank to remain effectively sealed for a top oil temperature range of -30 degrees to +105 degrees C.
 9. Lifting eyes and packing pads.
 10. Core/coil assembly to be of five-legged wound core type, using high grade, grain oriented silicon steel laminations carefully annealed after fabrication. The magnetic flux is to be kept well below saturation point.
 11. High voltage terminations and equipment to be dead front conforming to ANSI C57.12.26 requirements.
 12. Arranged for primary loop feed with 600A one-piece dead break bushings (6 required) with (2) two-position, 15 KV, 95KVBIL, 600A, 10KAIC gang-operated internal oil switches and one (1) on-off radial switch to de-energize transformer without opening loop-feed switches.
 13. Low voltage bushings to be molded epoxy, with blade-type space terminals with NEMA standard hole spacing arranged for vertical take-off. **NOTE: Refer to drawings for any**

special hole requirements. Low voltage neutral to be an insulating bushings, grounded to tank by removable strap.

14. High Voltage Full Capacity Taps: Four (4) nominal 2.5 percent taps, two above and two below rated high voltage for de-energized operation only, with externally operated tap changer. Tap changer operating handle shall be able to be padlocked.
15. Both front compartment doors to be removable.
16. ANSI tank grounding provisions in both compartments.
17. Fuse protection as follows: Externally replaceable, oil immersed Bay-O-Net type fuseholder, one per phase with one complete set of spare fuses.
18. 1" drain valve with externally accessible sampling device.
19. Parking stands.
20. The following additional optional accessories:
 - a. Dial type thermometer.
 - b. Liquid-level gauge.
 - c. Pressure vacuum gauge.
 - d. Pressure relief valve.
 - e. Nitrogen test/fill port with quick fill valve.
 - f. Automatic Pressure relief device (self resealing with indicator).
 - g. Stainless-steel ground connection pads.
 - h. Corrosion resistant machine engraved nameplate.
 - i. Base suitable for skidding and rolling in any direction.
 - j. (3) Three spare primary Bay-O-Net style fuse.

2.5 SERVICE CONDITIONS

- A. Transformers shall be suitable for operation under service conditions specified as usual service conditions in IEEE C57.12.00, except for the following:
1. Altitudes above 3300 feet.
 2. Cooling air temperature exceeds limits.
 3. Excessive load current harmonic factor.
 4. Operation above rated voltage or below rated frequency.
 5. Exposure to explosive environments.
 6. Exposure to fumes, vapors, or dust.
 7. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
 8. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
 9. Exposure to excessively high or low temperatures.
 10. Unusual transportation or storage conditions.
 11. Unusual grounding resistance conditions.

2.6 WARNING LABELS AND SIGNS

- A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

- A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.90.
1. Perform the following factory-certified routine tests on each transformer for this Project:
 - a. Resistance.
 - b. Turns ratio, polarity, and phase relation.
 - c. Transformer no-load losses and excitation current at 100 percent of ratings.
 - d. Transformer impedance voltage and load loss.
 - e. Operation of all devices.
 - f. Lightning impulse.
 - g. Low frequency.
 - h. Leak.
 - i. Transformer no-load losses and excitation current at 110 percent of ratings.
 - j. Insulation power factor.
 - k. Applied potential, except that this test is not required for single-phase transformers or for three-phase Y-Y-connected transformers.
 - l. Induced potential.
 - m. Resistance measurements of all windings on rated voltage connection and at tap extreme connections.
 - n. Ratios on rated voltage connection and at tap extreme connections.
 - o. Polarity and phase relation on rated voltage connection.
 - p. No-load loss at rated voltage on rated voltage connection.
 - q. Exciting current at rated voltage on rated voltage connection.
 - r. Impedance.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.
1. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.
 2. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
 3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
 4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on high- or low-voltage bushing parts, and at transformer base.
 5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
 6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.

7. Verify presence of polychlorinated biphenyl content labeling.
8. Unload transformers carefully, observing all packing label warnings and handling instructions.
9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer termination compartments against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.
6. Use jacks only at corners of tank base plate.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.
8. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

C. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Verify that an effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

D. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.
- F. Examine concrete bases for suitable conditions for transformer installation.
- G. Pre-Installation Checks: (to be delivered to owner at project conclusion.)
1. Verify removal of any shipping bracing after placement.
 2. Remove a sample of insulating liquid according to ASTM D923. Insulating-liquid values shall comply with NETA ATS, Table 100.4. Sample shall be tested for the following:
 - a. Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
 - b. Acid Neutralization Number: ASTM D974.
 - c. Interfacial Tension: ASTM D971.
 - d. Color: ASTM D1500.
 - e. Visual Condition: ASTM D1524.
 - f. Water in Insulating Liquids: Comply with ASTM D1533.
 - g. Power Factor or Dissipation Factor: ASTM D924.
 3. Turn over all paperwork/test data to KSU Engineer.
- H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer location.
- I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and IEEE C2.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems." Refer to drawings for details.
1. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
 2. Make joints in grounding conductors and loops by exothermic weld or compression connector.
 3. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure.
 4. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.

- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
 - 2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.
- C. Terminate medium-voltage cables in incoming section of transformers according to Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

- A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

Spec Writer note: Either A or B below is acceptable.

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections or
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
 - 1. General Field-Testing Requirements:
 - a. Comply with provisions of NFPA 70B Ch. "Testing and Test Methods."
 - b. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
 - c. After installing transformer but before primary is energized, verify that grounding system at the transformer is tested at specified value or less.
 - d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
 - e. Visual and Mechanical Inspection:
 - 1) Verify equipment nameplate data complies with Contract Documents.
 - 2) Inspect bolted electrical connections for high resistance using one of the following two methods:
 - a) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

- b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.
 - f. Remove and replace malfunctioning units and retest.
 - g. Prepare test and inspection reports. Record as-left set points of all adjustable devices.
- 2. Medium-Voltage Surge Arrester Field Tests:
 - a. Visual and Mechanical Inspection:
 - 1) Inspect physical and mechanical condition.
 - 2) Verify arresters are clean.
 - 3) Verify that ground lead on each device is individually attached to a ground bus or ground electrode.
 - b. Electrical Test:
 - 1) Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.
 - 2) Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.
- 3. Liquid-Filled Transformer Field Tests:
 - a. Visual and Mechanical Inspection:
 - 1) Test dew point of tank gases if applicable.
 - 2) Inspect anchorage, alignment, and grounding.
 - 3) Verify bushings are clean.
 - 4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
 - 5) Verify that liquid level in tanks is within manufacturer's published tolerances.
 - 6) Perform specific inspections and mechanical tests recommended by manufacturer.
 - 7) Verify presence of transformer surge arresters and that their ratings are as specified.
 - 8) Verify that as-left tap connections are as specified.
 - b. Electrical Tests:
 - 1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS,

Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.

- 2) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- 3) Remove a sample of insulating liquid according to ASTM D923, and perform dissolved-gas analysis according to IEEE C57.104 or ASTM D3612.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain systems.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 1. Transformer shall have two sets of three 600A bushings an in set and an out set. 15kv 600A dead-break terminations will be installed on the primary cables connected to these bushings. The termination will have a capacitive test point. The termination will have a reducer bushing and an elbow type surge arrestor installed rated at 8.4MCOV.
 2. Transformer in and out bushings shall have an integral under oil two-position 15kv, 600A rated switch.
 3. All windings and any internal cable to be copper.
 4. There shall be an integral two-position under oil 15kv rated two-position switch for the transformer windings.
 5. The transformer shall have removable oil immersed bayonet type primary fuse accessible from the high voltage compartment.
 6. The transformer shall have a total of 5 tap positions.
 - a. One (1) center tap
 - b. Two (2) +2.5% taps
 - c. Two (2) -2.5% taps
 7. Taps as indicated above shall be on the 13,200V windings.
 8. Insulating oils preferred: R-Temp or Enviro-Temp.
 9. Spill prevention and counter measures shall be considered when determining transformer location. Containment strategies shall be used to limit the risk of contamination to water sources (leak/spill) from oil filled transformers (do not place near storm drains).
 10. Barriers (concrete filled steel pipe with decorative PVC cover) shall be erected where transformer is subject to vehicular traffic (adjacent to streets, loading docks, etc.).
 11. There shall be a minimum of 10' clearance in front of the transformer to allow for hot-stick operation.
 12. Transformer doors to be equipped with stainless steel hinges and door stops.
 13. Doors to be tamperproof, served by a pentahead bolt and padlock arrangement.
 14. ANSI tank grounding provisions in both compartments
 15. 1" drain valve with sampling device.
 16. Parking stands for each primary bushing.
 17. Thermometer, liquid level gauge, pressure/Vacuum gauge, pressure relief valve, Nitrogen fill valve, Automatic pressure relief device.
 18. Transformers shall be Munsel Green.

19. Transformer typically mounted on a 12" thick steel reinforced concrete pad. 4" of pad shall be above grade. Concrete pad shall rest of min 8" crushed gravel base.

END OF SECTION 261219

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 500 kVA.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
 2. General Electric Company.
 3. Siemens Industry, Inc., Energy Management Division.
 4. Square D; by Schneider Electric.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
1. One leg per phase.
 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
 3. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
1. Coil Material: Copper.
 2. Internal Coil Connections: Brazed or pressure type.
 3. Terminal Connections: Bolted.

- D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- E. Enclosure: Ventilated.
 - 1. NEMA 250, Type 1: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
 - 2. KVA Ratings: Based on convection cooling only.
 - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 - 4. Finish: Comply with NEMA 250.
 - a. Finish Color: ANSI 61 gray weather-resistant enamel.
- F. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- K. Impedance shall not be less than 5.75%.
- L. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- M. Wall Brackets: Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.
- N. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
 - 1. 9.00 kVA and Less: 40 dBA.
 - 2. 9.01 to 30.00 kVA: 45 dBA.
 - 3. 30.01 to 50.00 kVA: 45 dBA.
 - 4. 50.01 to 150.00 kVA: 50 dBA.
 - 5. 150.01 to 300.00 kVA: 55 dBA.
 - 6. 300.01 to 500.00 kVA: 60 dBA.

2.4 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - 2. Electrical Tests:
 - a. Test secondary voltage to within 2.5% of nominal secondary voltage. Adjust taps to achieve close as possible to nominal voltage.
- B. Remove and replace units that do not pass tests or inspections and retest as specified above.
- C. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltage and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. All transformers are to be ventilated type.
 - 2. All transformers are to be copper wound.
 - 3. Transformers shall have 220°C Vacuum Pressure Impregnated (VPI) insulation.
 - 4. Transformers shall be designed with a 115°C rise.
 - 5. All transformers unless otherwise noted shall be delta primary and wye secondary.
 - 6. Transformers shall have two 2-1/2% taps FCAN and two 2-1/2% taps FCBN.
 - 7. All Building main transformers shall have cooling fans and a microprocessor temperature control panel. Each transformer winding shall have a temperature sensor.
 - 8. Transformers shall be set on 4"H steel reinforced concrete house-keeping pads.
 - 9. Transformers shall be provided with vibration isolation between transformer and mounting structure.
 - 10. Location of transformer shall be considered, prevent transformer install near walls adjacent to computer workstations and or teledata equipment.
Transformer impedance should be in the range of 5% unless specific design considerations dictate otherwise.

END OF SECTION 262213

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. HID: High-intensity discharge.
- D. MCCB: Molded-case circuit breaker.
- E. SPD: Surge protective device.
- F. VPR: Voltage protection rating.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.

5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Key interlock scheme drawing and sequence of operations.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Keys: Two spares for each type of panelboard cabinet lock.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.9 FIELD CONDITIONS

- A. Environmental Limitations:
 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

- b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify KSU Engineer no fewer than two weeks (10 Days) in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.
 - 3. Comply with NFPA 70E.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARD COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Height: 84 inches maximum, line up tops of dissimilar sized panelboards mounted adjacent to each other.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
 - a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components..

F. Incoming Mains:

1. Location: Top or Bottom, refer to electrical drawings.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.

6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- I. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 1. Percentage of Future Space Capacity: 25 percent minimum.
- K. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton.
 2. General Electric Company; GE Energy Management - Electrical Distribution.
 3. Siemens Industry, Inc., Energy Management Division.
 4. Square D; by Schneider Electric.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Lugs only, refer to electrical drawings.
- E. All Circuit-Breakers shall be Bolt-on type circuit breakers.

2.3 BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. [Eaton.](#)
2. [General Electric Company; GE Energy Management - Electrical Distribution.](#)
3. [Siemens Industry, Inc., Energy Management Division.](#)
4. [Square D; by Schneider Electric.](#)

- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:

1. [Eaton.](#)
2. [General Electric Company; GE Energy Management - Electrical Distribution.](#)
3. [Siemens Industry, Inc., Energy Management Division.](#)
4. [Square D; by Schneider Electric.](#)

- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.

- 4) Ground-fault pickup level, time delay, and I squared T response.
4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
5. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
6. Subfeed Circuit Breakers: Vertically mounted.
7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - h. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units. Unless otherwise noted on the drawings.
 - i. Multipole units enclosed in a single housing with a single handle.
 - j. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
 - k. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.
- D. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.

2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- L. Install filler plates in unused spaces.
- M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- N. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Tests and Inspections:
 1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Panelboards will be considered defective if they do not pass tests and inspections.

- D. Prepare test and inspection reports, including a certified report that identifies panelboards included. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 - 1. Measure loads during period of normal facility operations.
 - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 - 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. All panelboards will be three phase 4 wire unless permission is granted by university engineer.
 - 2. Locate panelboards in dedicated electrical closets, teledata closets (dedicated teledata equipment loads), electrical rooms or mechanical equipment rooms.
 - 3. To accommodate future loads provide spare conduit stubs (30%) from flush panels into suspended ceiling space, floor below, or other accessible space.
 - 4. All panelboards must have copper bus (phase, neutral and ground).
 - 5. All bus should be rated for 100% capacity including the neutral.
 - 6. All panels should be designed with 25 – 40% spare capacity with regard to the total load on the panel and the number of spare breakers. If additional circuits are required a second panelboard should be installed.
 - 7. All panels should be purchased with a complete set of breakers. All spare/spaces should be filled with breakers. Typically all 208/120V panelboards will be filled with spare 20A single pole breakers. 42 circuit panelboards are typical standard.
 - 8. All breakers will be bolt-on style breakers.
 - 9. All equipment is to be door-in-door construction.

10. Where panelboards are recessed in finished walls, a minimum of (3) three spare 1" conduits shall be stubbed from the panelboard to above accessible ceiling space.
11. For Special applications refer back to TVSS requirements.
12. Where 20A/1P branch circuits require ground fault and or arc fault protection, the protective device shall not be the circuit breaker. AFCI and GFCI receptacles are preferred.
13. Main circuit breakers shall be avoided. Main overcurrent protection shall be outside of branch circuit panelboards whenever possible.
14. Contractor shall provide coordination study, short circuit analysis, arc flash analysis and labeling. See "Electrical System Studies".

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Standard-grade receptacles, 125 V, 20 A.
2. USB receptacles.
3. GFCI receptacles, 125 V, 20 A.
4. Twist-locking receptacles.
5. Pendant cord-connector devices.
6. Cord and plug sets.
7. Toggle switches, 120/277 V, 20 A.
8. Occupancy sensors.
9. Digital timer light switches.
10. Wall-box dimmers.
11. Wall plates.
12. Poke-through assemblies.
13. Prefabricated multi-outlet assemblies.
14. Service poles.

1.3 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.

1.4 SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Service-Outlet Assemblies: Provide one cover for every 10, but no fewer than one. Provide a minimum of one entire assembly.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Comply with NEMA WD 1.
- E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with requirements in this Section.
- F. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- G. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.

H. Wall Plate Color: For plastic covers, match device color.

I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton (Arrow Hart).
2. Hubbell Incorporated; Wiring Device-Kellems.
3. Leviton Manufacturing Co., Inc.
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Duplex Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.

C. Tamper-Resistant Duplex Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.
4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

D. Weather-Resistant Duplex Receptacle, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

E. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.3 USB RECEPTACLES

- A. USB Charging Receptacles:
 - 1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
 - 2. USB Receptacles: Dual and quad, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
 - 3. Standards: Comply with UL 1310 and USB 3.0 devices.
- B. Tamper-Resistant Duplex and USB Charging Receptacles:
 - 1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Integral shutters that operate only when a plug is inserted in the line voltage receptacle.
 - 2. Line Voltage Receptacles: Two pole, three wire, and self-grounding; NEMA WD 6, Configuration 5-20R.
 - 3. USB Receptacles: Dual USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
 - 4. Standards: Comply with UL 498, UL 1310, USB 3.0 devices, and FS W-C-596.
 - 5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

2.4 GFCI RECEPTACLES, 125 V, 20 A

- A. Duplex GFCI Receptacles, 125 V, 20 A:
 - 1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
 - 2. Configuration: NEMA WD 6, Configuration 5-20R.
 - 3. Type: Feed through.
 - 4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
- B. Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A:
 - 1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
 - 2. Configuration: NEMA WD 6, Configuration 5-20R.
 - 3. Type: Feed through.
 - 4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
 - 5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.
- C. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:
 - 1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
 - 2. Configuration: NEMA WD 6, Configuration 5-15R.
 - 3. Type: Feed through.
 - 4. Standards: Comply with UL 498 and UL 943 Class A.
 - 5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.5 TWIST-LOCKING RECEPTACLES

- A. Twist-Lock, Single Receptacles, 120 V, 20 A:
 - 1. Configuration: NEMA WD 6, Configuration L5-20R.
 - 2. Standards: Comply with UL 498.
- B. Twist-Lock, Single Receptacles, 250 V, 20 A:
 - 1. Configuration: NEMA WD 6, Configuration L6-20R.
 - 2. Standards: Comply with UL 498.
- C. Twist-Lock, Single Receptacles, 277 V, 20 A:
 - 1. Configuration: NEMA WD 6, Configuration L7-20R.
 - 2. Standards: Comply with UL 498.

2.6 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.
- B. Configuration: NEMA WD 6, Configurations L5-20P and L5-20R.
- C. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
- D. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.
- E. Standards: Comply with FS W-C-596.

2.7 CORD AND PLUG SETS

- A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
- B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
- C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 TOGGLE SWITCHES, 120/277 V, 20 A

- A. Single-Pole Switches, 120/277 V, 20 A:
 - 1. Standards: Comply with UL 20 and FS W-S-896.
- B. Two-Pole Switches, 120/277 V, 20 A:
 - 1. Comply with UL 20 and FS W-S-896.
- C. Three-Way Switches, 120/277 V, 20 A:

1. Comply with UL 20 and FS W-S-896.
- D. Four-Way Switches, 120/277 V, 20 A:
 1. Standards: Comply with UL 20 and FS W-S-896.
- E. Pilot-Light, Single-Pole Switches: 120/277 V, 20 A:
 1. Description: Illuminated when switch is on.
 2. Standards: Comply with UL 20 and FS W-S-896.
- F. Lighted Single-Pole Switches, 120/277 V, 20 A:
 1. Description: Handle illuminated when switch is on.
 2. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.
- G. Key-Operated, Single-Pole Switches, 120/277 V, 20 A:
 1. Description: Factory-supplied key in lieu of switch handle.
 2. Standards: Comply with UL 20 and FS W-S-896.

2.9 OCCUPANCY SENSORS

- A. Wall Switch Sensor Light Switch, Dual Technology:
 1. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual (ultrasonic and passive infrared) technology.
 2. Standards: Comply with UL 20.
 3. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
 4. Adjustable time delay of 20 minutes.
 5. Able to be locked to Automatic or Manual-On mode.
 6. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
 7. Connections: Provisions for connection to BAS.
 8. Connections: RJ-45 communications outlet.
 9. Connections: Integral wireless networking.
- B. Wall Sensor Light Switch, Passive Infrared:
 1. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using passive infrared technology.
 2. Standards: Comply with UL 20.
 3. Connections: Provisions for connection to BAS.
 4. Connections: Hard wired as specified on drawing.
 5. Connections: Wireless as specified on drawing.
 6. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
 7. Integral relay for connection to BAS, only as noted on drawing.
 8. Adjustable time delay of 20 minutes.
 9. Able to be locked to Automatic or Manual-On mode.
 10. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
- C. Wall Sensor Light Switch, Ultrasonic:
 1. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using ultrasonic technology.
 2. Standards: Comply with UL 20.

3. Connections: Provisions for connection to BAS.
4. Connections: RJ-45 communications outlet as specified on drawings.
5. Connections: Integral wireless networking as specified on drawings.
6. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
7. Integral relay for connection to BAS.
8. Adjustable time delay of 20 minutes.
9. Able to be locked to Automatic or Manual-On mode.
10. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.

2.10 TIMER LIGHT SWITCH

A. Digital Timer Light Switch:

1. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with selectable time interval in 20-minute increments.
2. Standards: Comply with UL 20.
3. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.

2.11 DIMMERS

A. Wall-Box Dimmers:

1. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
2. Control: Continuously adjustable slider; with single-pole or three-way switching.
3. Standards: Comply with UL 1472.
4. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness. 0-10V control without the use of an additional supply.

2.12 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.13 POKE-THROUGH ASSEMBLIES

- A. Description: Recessed type factory-fabricated and -wired assembly of below-floor junction box with multichannel, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly. Devices shall be recessed below floor level with closing scrub proof cover to conceal connectors.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems. (System Recessed)
 - 2. Wiremold / Legrand. (Evolution Type)
- C. Standards: Comply with scrub water exclusion requirements in UL 514.
- D. Service-Outlet Assembly: Pedestal type with services indicated, complying with requirements in Section 271513 "Communications Copper Horizontal Cabling."
- E. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
- F. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
- G. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
- H. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, four-pair cables that comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

2.14 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Description: Two-piece surface metal raceway, with factory-wired multioutlet harness.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Wiremold / Legrand.
- C. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- D. Raceway Material: Metal, with manufacturer's standard finish.
- E. Multioutlet Harness:
 - 1. Receptacles: 20-A, 125-V, Configuration 5-20R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
 - 2. Receptacle Spacing: 9 inches.
 - 3. Wiring: No. 12 AWG, Type THHN copper, single circuit or two circuit, connecting alternating receptacles as shown on electrical drawings.

2.15 SERVICE POLES

A. Dual-Channel Service Poles (Refer to electrical drawings for additional information):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Premise Wiring.
 - b. Panduit Corp.
2. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
3. Poles: Nominal 2.5-inch-square cross-section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
4. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
5. Material: Aluminum.
6. Finishes: Manufacturer's standard painted finish and trim combination.
7. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, balanced twisted pair data communication cables.
8. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.
9. Data Communication Outlets: Refer to Division 27.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through GFCI receptacles.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use preprinted tape label (PTouch) machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Wiring device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. Hubbell is the preferred manufacturer.

2. Shop drawings are required for all wiring devices.
3. All devices shall be Specification grade.
4. All switches shall be AC, quiet type rated 20A 120/277V.
5. All general purpose receptacles shall be rated 20A.
6. Receptacles and switches shall be side and back wiring type. Any wire connection shall be screw clamp type.
7. Receptacles and communication/data outlets shall be 18" AFF and 6" to center of device over counter top backsplash. In Tunnels, attic spaces, mechanical rooms install receptacles 42" AFF.
8. Receptacles shall be provided on ground floor of stairwells and lobby.
9. Corridors shall be provided with duplex receptacles 35' on center and a maximum of 15' from the end of the corridor. These receptacles shall be on separate circuits from the room circuits.
10. Make provisions for receptacles in wall or floor for Podium in Lecture Halls.
11. Mechanical and electrical rooms shall typically be provided with one receptacle per wall.
12. Switches provided at roof hatches or where provided outside of rooms they are serving shall be provided with pilot lights (LED).
13. To reduce sound transmission wall outlet boxes shall not be installed back to back.
14. Faceplates are to be stainless steel or nylon – determination to be made via shop drawing submittals. Color selection to be made via shop drawing submittals.
15. Any GFCI outlets should not feed through to other outlets. No downstream protection.
16. GFCI receptacles shall be used in any location in which the device could potentially get wet or damp (i.e. All Science Labs). GFCI breakers are prohibited for 20A 120V circuits.
17. GFCI receptacles shall be installed in all mechanical rooms.
18. TVSS receptacles are not typically used.
19. See detail for pendant style wiring support using Kellum Grips.
20. All dimming control switches should be 0-10V type.
21. Occupancy sensors shall be by Wattstopper, Sensor Switch/N-Light or Lutron.
22. In wet locations, exterior or potentially wet locations, the devices should be weather tight while in use. Covers shall be diecast metal. Plastic covers are prohibited.
23. All mounting heights shall comply with ADA.
24. Electrical outlets should be installed with the grounding pin on top.
25. All receptacles are to be tested to insure proper wiring and GFCI operation.
26. Consider using USB receptacles in areas where students will likely congregate.
27. Use arc-fault receptacles in residence hall rooms where required per NEC.
28. Provide circuit number either on the coverplate front with a P-touch labeler or on the backside of the coverplate with permanent marker.
29. Provide AFCI receptacles where required by code. AFCI breakers are not permitted.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Motor-control centers.
 - c. Switchboards.
 - d. Enclosed controllers.
 - e. Enclosed switches.
2. Spare-fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 3. Current-limitation curves for fuses with current-limiting characteristics.
 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
 5. Coordination charts and tables and related data.
 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," include the following:
1. Ambient temperature adjustment information.
 2. Current-limitation curves for fuses with current-limiting characteristics.
 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
 4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bussmann, an Eaton business.
 2. Edison; a brand of Bussmann by Eaton.
 3. Littelfuse, Inc.
 4. Mersen USA.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
1. Type RK-1: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay.

2. Type RK-5: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, time delay.
 4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, time delay.
 5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
 7. Type T: 250-V, zero- to 1200-A or 600-V, zero- to 800-A rating, 200 kAIC, time delay.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
1. Size: Adequate for storage of spare fuses specified with 10 percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, time delay.
2. Feeders: Class RK1.
3. Motor Branch Circuits: Class RK5, time delay.
4. Large Motor Branch: Fuse type appropriate to conform to coordination study.
5. Power Electronics Circuits: Fuse type appropriate to conform to coordination study.
6. Other Branch Circuits: Fuse type appropriate to conform to coordination study.
7. Control Transformer Circuits: Class CC, time delay, control transformer duty.
8. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by KSU Engineer.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

PART 4 - PART 1 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University (KSU). Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 1. UL classification fuses shall be used as required for coordination, time delay and current limitation requirements.
 2. All fuses are to be non-renewable.
 3. If fuses are specified, a complete set of spare fuses minimum 10% or three per type whichever is more, should be included with the project.
 4. A fuse cabinet shall be provided to store spare fuses.
 5. Use class RK1 or RK5, 200,000 AIC rated fuses for up to 600amp applications.
 6. Where specified fuses for secondary service mains and feeders over 600amp shall be class L.
 7. All fuses shall be by one manufacturer.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.

2. Include wiring diagrams for power, signal, and control wiring.

1.5 CLOSEOUT DOCUMENTS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.6 MAINTENANCE MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 2. Fuse Pullers: Two for each size and type.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Inc.
 - 2. Eaton.
 - 3. General Electric Company.
 - 4. Siemens Industry, Inc., Energy Management Division.
 - 5. Square D; by Schneider Electric.
- B. Type HD, Heavy Duty:
 - 1. Single throw.
 - 2. Three pole.
 - 3. 240 or 600-V ac.
 - 4. 1200 A and smaller.
 - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
 - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 5. Service-Rated Switches: Labeled for use as service equipment. Provide as indicated on drawings.

2.3 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. [Eaton.](#)
 2. [General Electric Company.](#)
 3. [Siemens Industry, Inc., Energy Management Division.](#)
 4. [Square D; by Schneider Electric.](#)
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors..
 3. Lugs: Mechanical type, suitable for number, size, and conductor material.
 4. Service-Rated Switches: Labeled for use as service equipment. Provide as indicated on drawings.

2.4 SHUNT TRIP SWITCHES

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
1. [Eaton.](#)
 2. [Bussman.](#)
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.
- C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 240 or 600-V ac, amperage as indicated on drawings; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, pilot, indicating and control devices.
- E. Accessories:
1. Oiltight key switch for key-to-test function.
 2. Oiltight red ON pilot light.
 3. Neutral lug; 100 percent rating.
 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 5. Form C alarm contacts that change state when switch is tripped.
 6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac coil voltage.
 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

8. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
9. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
10. Auxiliary Contact Kit: TwoNO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
11. Hookstick Handle: Allows use of a hookstick to operate the handle.
12. Lugs: Mechanical type, suitable for number, size, and conductor material.
13. Service-Rated Switches: Labeled for use as service equipment.

2.5 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton.
 2. General Electric Company.
 3. Siemens Industry, Inc., Energy Management Division.
 4. Square D; by Schneider Electric.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.
- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F(75 deg C) temperature rating in NFPA 70.
- G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- M. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- N. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

Retain first option in first subparagraph below for solid-state trip units; retain second option for thermal-magnetic trip units.

- 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
- 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
- 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
- 7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- 8. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
- 9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- 10. Accessory Control Power Voltage: Integrally mounted, self-powered;.

2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel.

- C. Conduit Entry: Knock-outs for Type 1 and threaded hubs for Type 3R and Stainless Steel Type 4X.
- D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the dead front trim of the enclosure. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect and KSU Engineer no fewer than 2 weeks (ten working days) in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without KSU Engineer's written permission.
 - 4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R Type 4X.
 - 3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 3R.
 - 5. Type 12.
 - 6. Hazardous Areas Indicated on Drawings.: Type 9.

3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - h. Verify correct phase barrier installation.
 - i. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
- C. Tests and Inspections for Molded Case Circuit Breakers:
 - 1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that the unit is clean.
 - e. Operate the circuit breaker to ensure smooth operation.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. Enclosed switch/breaker shall have lockable handle that interlocks with closed cover.
 - 2. Enclosed switch/breaker shall be fully rated to interrupt full load running current of any connected motor loads and have current interrupt ratings that meet or exceed available fault currents (Series rated equipment is not acceptable).
 - 3. Enclosed switches shall be heavy duty rated.
 - 4. Enclosed switch/breaker shall have internally mounted equipment ground kit.
 - 5. For circuits with neutral conductor are used switch/breaker enclosure shall have a neutral kit.
 - 6. The enclosures shall be Nema 1 or 12 in general areas, Nema 3R outdoors, Nema 4X in kitchen and in areas with corrosive environment.
 - 7. Provide warning labeling per "Electrical System Studies" (Arc Flash labeling...)
 - 8. Properly mount switches/breakers to structure at heights per ADA.
 - 9. Company Switch: Company Switch breaker shall have a shunt trip mechanism by the
 - 10. SafeCam" System. The main breaker shall be tripped unless all outlets have a plug inserted in them. Breaker will also trip if access door to the connection chamber is open. The bottom of the enclosure shall have a hinged flap for load cable access. The flap shall be locked when the connection chamber is not being used. Outlets shall be SafeCam devices mounted on the bottom of the enclosure. The Company Switch shall be PBS/SP Type as manufactured by Union Connector Co.

END OF SECTION 262816

SECTION 262913 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Manual motor controllers.
2. Enclosed full-voltage magnetic motor controllers.
3. Combination full-voltage magnetic motor controllers.
4. Enclosures.
5. Accessories.
6. Identification.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. NC: Normally closed.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SCPD: Short-circuit protective device.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of magnetic controller.
 1. Include plans, elevations, sections, and mounting details.
 2. Indicate dimensions, weights, required clearances, and location and size of each field connection.

3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
 - a. Listing document proving Type 2 coordination.

1.5 CLOSEOUT DOCUMENTATION

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Routine maintenance requirements for magnetic controllers and installed components.
 - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - c. Manufacturer's written instructions for setting field-adjustable overload relays.
 - d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
 - e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; connect factory-installed space heaters to temporary electrical service.

1.8 FIELD CONDITIONS

- A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.2 MANUAL MOTOR CONTROLLERS

- A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. General Electric Company.
 - c. Rockwell Automation, Inc.
 - d. Siemens Industry, Inc., Energy Management Division.

- e. [Square D; by Schneider Electric.](#)
 - 2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
 - 3. Configuration: Nonreversing.
 - 4. Flush or Surface mounting.
 - 5. Red pilot light.
- B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" lockable toggle or push-button action; marked to show whether unit is off, on, or tripped.
- 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Eaton.](#)
 - b. [General Electric Company.](#)
 - c. [Rockwell Automation, Inc.](#)
 - d. [Siemens Industry, Inc., Energy Management Division.](#)
 - e. [Square D; by Schneider Electric.](#)
 - 2. Configuration: Nonreversing.
 - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.
 - 4. Overload Relays: NEMA ICS 2, bimetallic class as schedule on Drawings.
 - 5. Pilot Light: Red.
- C. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" lockable toggle or push-button action; marked to show whether unit is off, on, or tripped.
- 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Eaton.](#)
 - b. [General Electric Company.](#)
 - c. [Rockwell Automation, Inc.](#)
 - d. [Siemens Industry, Inc., Energy Management Division.](#)
 - e. [Square D; by Schneider Electric.](#)
 - 2. Configuration: Nonreversing.
 - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.
 - 4. Overload Relays: NEMA ICS 2, bimetallic class as scheduled on Drawings.

2.3 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

- A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
 2. General Electric Company.
 3. Rockwell Automation, Inc.
 4. Siemens Industry, Inc., Energy Management Division.
 5. Square D; by Schneider Electric.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing.
- E. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.
1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. Spare CPT Capacity as Indicated on Drawings: 100 VA.
- G. Overload Relays:
1. Thermal Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.
 - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 - e. Automatic resetting.
 2. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

2.4 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

- A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. [Eaton.](#)
 2. [General Electric Company.](#)
 3. [Rockwell Automation, Inc.](#)
 4. [Siemens Industry, Inc., Energy Management Division.](#)
 5. [Square D; by Schneider Electric.](#)
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing Insert configuration.
- E. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.
1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
- G. Spare CPT Capacity as Indicated on Drawings: 100 VA.
- H. Overload Relays:
1. Thermal Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.
 - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 - e. Automatic resetting.
 2. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
- I. Fusible Disconnecting Means:
1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- J. MCCB Disconnecting Means:
1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5 ENCLOSURES

- A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.
- B. The construction of the enclosures shall comply with NEMA ICS 6.
- C. Controllers in hazardous (classified) locations shall comply with UL 1203.

2.6 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
 - a. Push Buttons: As indicated in the controller schedule.
 - b. Pilot Lights: As indicated in the controller schedule.
 - c. Hand off auto.
 - d. Pilot light illuminated while running (push to test).
 - e. Additional features: 1. Two sets of extra contacts normally open and normally closed.
 - f. Two (2) primary fuses, one (1) secondary fuse one secondary cct.

2.7 IDENTIFICATION

- A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.
- B. Arc-Flash Warning Labels:
 1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify the unit is clean.
 - e. Inspect contactors:
 - 1) Verify mechanical operation.
 - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
 - f. Motor-Running Protection:
 - 1) Verify overload element rating is correct for its application.
 - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
- B. Motor controller will be considered defective if it does not pass tests and inspections.

3.5 SYSTEM FUNCTION TESTS

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.
 - 1. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
 - 2. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Motor controller will be considered defective if it does not pass the system function tests and inspections.
- C. Prepare test and inspection reports.

PART 4 - KSU Design Requirements

- 4.1 The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. Enclosed controllers shall have lockable handle that interlocks with closed cover.
 - 2. Enclosed fused switch/breaker shall be fully rated to interrupt full load running current of any connected motor loads and have current interrupt ratings that meet or exceed available fault currents (Series rated equipment is not acceptable).
 - 3. The enclosures shall be Nema 1 or 12 in general areas, Nema 3R outdoors.
 - 4. Enclosures shall be mounted at 5' to operating handle.
 - 5. The contactor shall be Nema rated.
 - 6. Each motor starter shall have it's own control power source for shunt trip voltage and or control power. The control circuit voltage should be 120V.
 - 7. Consider the use motor circuit protectors or inverse time molded case breakers instead of fuses. If fuses are provided consider single phase protection relays. If fuses are used a spare fuse cabinet shall be provided and installed with spare fuses.
 - 8. Hand/Off/Auto selecting switch, run buttons and off buttons all should have a push to test for all lamps (all test lamps should be L.E.D.).
 - 9. Motor Starters shall have (2) N.C. and (2) N.O. auxiliary contacts minimum.
 - 10. The contractor shall provide coordination study, short circuit analysis, arc flash analysis and labeling. See "Electrical System Studies".

END OF SECTION 262913.03

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes lightning protection system for ordinary structures.

1.3 SUBMITTALS

- A. Shop Drawings:

1. Include project specific roof plan of the lightning protection system, with details of the components to be used in the installation and bonding to roof mounted equipment.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.4 CLOSEOUT DOCUMENTS

- A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
 - b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

- B. Completion Certificate:

1. UL Master Label Certificate.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: UL-listed installer, category OWAY.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advanced Lightning Technology, Ltd.
 - 2. East Coast Lightning Equipment Inc.
 - 3. ERICO; a brand of nVent.
 - 4. Harger Lightning & Grounding.
 - 5. Heary Bros. Lightning Protection Co. Inc.
 - 6. Independent Protection Co.
 - 7. National Lightning Protection.
 - 8. Preferred Lightning Protection.
 - 9. Robbins Lightning, Inc.
 - 10. Thompson Lightning Protection, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I or Class II buildings.
- B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I or Class II buildings.
- C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

- A. Air Terminals:
 - 1. Solid Aluminum unless otherwise indicated.
 - 2. Diameter and height to be selected by installer to meet UL master label.
 - 3. Rounded tip.
 - 4. Integral base support.
- B. Air Terminal Bracing:
 - 1. Aluminum.
 - 2. 1/4-inch diameter rod.

- C. Class I Main Conductors:
 - 1. Aluminum: 98,600 circular mils in diameter.
- D. Class II Main Conductors:
- E. Stranded Copper: 115,000 circular mils in diameter.
- F. Aluminum: 192,000 circular mils in diameter.
- G. Secondary Conductors:
 - 1. Aluminum: 41,400 circular mils in diameter.
- H. Ground Loop Conductor: Stranded copper.
- I. Ground Rods:
 - 1. Material: Solid copper.
 - 2. Diameter: 5/8 inch.
 - 3. Rods shall be not less than 120 inches long.
- J. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.
- C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed systems in NFPA 780.
 - 1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
 - 2. Install conduit where necessary to comply with conductor concealment requirements.
 - 3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.
- D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

- A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.
- B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: high compression.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. Perform inspections as required to obtain a UL Master Label for system.
- B. Prepare test and inspection reports and certificates.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. Lightning protection shall be installed for every new building, addition or roofing project.
 - 2. It shall also be considered for existing buildings undergoing large scale renovations.
 - 3. All lightning protection design must meet UL96A and NFPA780. Contractor must apply for and receive U.L. Master Label Certification.
 - 4. Witchey Lightning Rod Company and Western Reserve Lightning Protection Company have been used successfully in the past to perform design and build projects.
 - 5. Grounding connections shall be made using a permanently effective with high compression fittings or with exothermic welds.

6. All non-current carrying metallic structure/framing within 12' of lightning protection conductors shall be grounded.
7. Typically utilize solid air terminals with the proper stranded cable. These air terminals shall typically extend 2' above roof or equipment.
8. Protection should be provided at the perimeter of all buildings and on top of any equipment that extends above the perimeter elevation.
9. Air terminals shall be copper.
10. Down conductors shall be protected by sleeving in sch80 PVC from below grade to 72" above finished grade.
11. There shall be multiple down wires with connections to ground rods at the base of the building. Rods shall be copper 5/8" diameter x 10' long.
12. There shall be one connection to the building grounding electrode system at the MDP.

END OF SECTION 264113

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Requirements:
 - 1. Section 262413 "Switchboards" for factory-installed SPDs.
 - 2. Section 262416 "Panelboards" for factory-installed SPDs.

1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.5 CLOSEOUT DOCUMENTS

- A. Maintenance Data: For SPDs to include in maintenance manuals.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton.
 2. Current Technologies, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. Liebert; a brand of Vertiv.
 5. Schneider Electric USA, Inc.
 6. Siemens Industry, Inc., Energy Management Division.
 7. SSI, an ILSCO Company.
- B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1
 1. SPDs with the following features and accessories:
 - a. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

- b. Include LED indicator lights for power and protection status.
 - c. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - d. Six Digit Surge counter.
 - e. Integral Disconnect switch
 - f. Constructed with copper bus.
- C. Comply with UL 1283.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 320 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

REVISE VOLTAGE BELOW PER PROJECT

- E. Protection modes and UL 1449 VPR for grounded wye circuits with **[480Y/277 V]** **[208Y/120 V]**, three-phase, four-wire circuits shall not exceed the following:
- 1. Line to Neutral: **[1200 V for 480Y/277 V]** **[700 V for 208Y/120 V]**.
 - 2. Line to Ground: **[1200 V for 480Y/277 V]** **[1200 V for 208Y/120 V]**.
 - 3. Line to Line: **[2000 V for 480Y/277 V]** **[1000 V for 208Y/120 V]**.
- F. SCCR: Equal or exceed 200 kA.
- G. Nominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Eaton.
 - 2. Current Technologies, Inc.
 - 3. Leviton Manufacturing Co., Inc.
 - 4. Liebert; a brand of Vertiv.
 - 5. Schneider Electric USA, Inc.
 - 6. Siemens Industry, Inc., Energy Management Division.
 - 7. SSI, an ILSCO Company.
- B. SPDs: Comply with UL 1449, Type 3.
- 1. Include LED indicator lights for power and protection status.
 - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - 3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 120 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Comply with UL 1283.

MAKE VOLTAGE SELECTION BELOW PER PROJECT

- E. Protection modes and UL 1449 VPR for grounded wye circuits with **[480Y/277 V]** **[208Y/120 V]**, three-phase, four-wire circuits shall not exceed the following:
 - 1. Line to Neutral: **[1200 V for 480Y/277 V]** **[700 V for 208Y/120 V]**.
 - 2. Line to Ground: **[1200 V for 480Y/277 V]** **[700 V for 208Y/120 V]**.
 - 3. Neutral to Ground: **[1200 V for 480Y/277 V]** **[700 V for 208Y/120 V]**.
 - 4. Line to Line: **[2000 V for 480Y/277 V]** **[1200 V for 208Y/120 V]**
- F. SCCR: Equal or exceed 100 kA.
- G. Inominal Rating: 20 kA.

2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring: Same size or larger as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 2. Inspect anchorage, alignment, grounding, and clearances.
 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to operate and maintain SPDs.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 1. Surge Protection Devices shall comply with UL1449.
 2. TVSS should be considered at MDP for every building and at every panel that will have critical electronic loads connected to it (teledata equipment racks, servers, etc).
 3. TVSS devices should be incorporated into the panel or as close as is practical to the panel that it is protecting.
 4. TVSS shall be installed per manufacturers recommendations. Installation shall keep conductors as short as possible with as few bends as possible.
 5. The TVSS unit must be able to be serviced or replaced without interrupting power to the panel.

6. Shall be of modular design with field replaceable modules.
7. Shall contain fuses rated 200kA interrupting rating.
8. Shall contain integral disconnect switch.
9. Shall be constructed with copper bus.
10. Shall have LED indicator lamps for power and protection status.
11. Local and remote monitoring functions are required. Shall have audible alarm with silence switch that will activate upon failure of surge module or fuse. Shall have form C contacts for remote monitoring. Contacts shall change state upon failure of surge module or fuse.
12. Six digit transient event counter.
13. Peak Single –Impulse Surge rating at Service of 320kA.
14. 1200V for 480/277V systems
15. 700V for 208Y/120V systems
16. Panelboard Supression (for telecommunications rooms at a minimum) can be non-modular connected to 3pole breaker in panelboard. Utilize 3pole breaker for isolation of surge suppressor modules. Peak Single-Impulse rating at Panelboard of 120kA.

END OF SECTION 264313

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:

- 1. Interior LED luminaries, lamps, and drivers.
 - 2. Luminaire supports.

- B. Related Requirements:

- 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.

4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 1. Provide a list of all luminaire types used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Drivers: One for every 10 of each type installed. Furnish at least one of each type.
 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. CRI of 80. CCT :

1. 3000-3500K for Resident Halls or similar.
2. 2700K for Food Service or Dining.
3. 4000K for Academic Building type.

F. Rated lamp life of 35,000 (minimum) hours.

G. Drivers shall be dimmable from 100 percent to 10 percent of maximum light output with 0-10V input signal.

H. Driver shall be accessible when ceiling is finished without the use of an access panel.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) minimum from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product or its listed engineer's approved equivalent product indicated on drawings.

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Recessed luminaires shall comply with NEMA LE 4.

C. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Diffusers:

1. Prismatic
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

C. Housings: Refer to Lighting Fixture Schedule on Drawings.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install drivers for each luminaire.
- D. Supports:
 - 1. All fixtures to be supported securely from building structure and/or walls and the responsibility for mounting same shall be that of this Contractor.
 - a. Where surface mounted fixtures are mounted from "lay-in" type ceilings, the fixtures shall be supported independent of respective lay-in panel channel support system and fastened to the building structural system. Support from all 4-corners.
 - b. Wall mounted fluorescent fixtures to have additional 1/4" toggle bolt (or equivalent) support at each end of module.
 - 2. Sized and rated for luminaire weight.
 - 3. Able to maintain luminaire position after cleaning.
 - 4. Provide support for luminaire without causing deflection of ceiling or wall.
 - 5. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaires:
 - 1. Attached using through bolts and backing plates on either side of wall.
 - 2. Do not attach luminaires directly to gypsum board for structural support.
- G. Suspended Luminaires:
 - 1. Ceiling Mount Options:
 - a. Two 5/32-inch- diameter aircraft cable supports adjustable to 10 feet in length or as specified on drawings.
 - b. Pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 10 feet in length or as specified on drawings.
 - c. Hook mount.
 - 2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Comply with requirements for startup of lighting controls for specialty lighting and lighting controls.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied

conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

PART 4 - KSU Design Requirements

A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.

1. Foot-candle calculations, including IES test data and IES files, photometric values, and design parameters (including which walls have what reflectance on them) are to be presented to KSU Engineer for approval.
2. All office, classroom, restroom, lecture hall, corridor, etc. spaces will have some form of occupancy sensor device (wall switch or ceiling sensor).
3. In some of the common areas in the paths of egress there will be a few night lights (top of stairwell, long corridors, etc. (total emergency lighting shall be not less than 10% but not more than 50% of total lighting).
4. Mechanical and electrical rooms should have timers for the majority of the lighting with a few night lights. The night lights would burn 24/7.
5. In utility rooms such as mechanical room, electrical room, teledata rooms, tunnels etc specify the standard surface mount vapor-tight fixtures (Metalux, Lithonia, Hubbell or Philips).
6. Fixtures should be located in such a way that they are accessible for maintenance and replacement.
7. Fixtures will not be air-supply type they will be static.
8. A minimum amount of varying lamp types should be utilized on each project.
9. 4000K color rendering lamps are preferred. 3000K shall be used for residence halls, dining areas and special applications.
10. Applications utilizing incandescent lamp types shall be used only as last resort and if possible consider LED lamp source for these. Use must be justifiable and approved by KSU engineer.
11. Emergency lighting shall be provided per NFPA and as a minimum in a percentage of fixtures in all corridors stairwells, large lecture halls, public restrooms and other areas where you would have to pass through more than one door to exit into the egress corridor.
12. Emergency lighting shall consist of a percentage of fixtures tied into the building generator if one is available. These emergency fixtures would be circuited as a night light or through an emergency transfer device such as GTD-20 manufactured by Bodine.
13. A percentage of emergency lighting fixtures can also be comprised of stand-alone light fixtures with integral battery backup. These devices shall have self-diagnostics, a battery charging circuit and a push to test button. Lamp source shall be LED (Gilbert Inc). Emergency battery ballasts installed within light fixtures are acceptable where aesthetics is an issue, these shall be as manufactured by "Bodine".
14. Tandem or cross ballasting of adjacent fixtures shall be permitted only if fixtures are directly connected to each other.

15. Only program start fully rated electronic ballasts with less than 10% harmonic distortion are acceptable for non-dimmed fluorescent lamps.
16. All exit signs shall be LED. type with integral battery charger, self-testing diagnostics and a push to test button.
17. All fixtures should be supported on multiple sides (4 corners for 2x2 or 2x4 recessed fixtures) from the building structure. The lights are not to be supported by the suspended ceiling grid. The support wires should be installed by the Contractor installing the suspended ceiling.
18. Where enough ambient light is available and dimming ballasts are required, our typical lighting control system for general classroom applications will be the Lutron 0-10V utilizing occupancy sensor(s) and daylight sensor(s) with a multi-button switch at entrance and one at teaching station. Where there is not enough ambient lighting and or dimming is not required in general classrooms, program start ballasts with occupancy sensors shall be used with multiple zone switching wired so that the first row or two of lights controlled separately than the remainder of the room. There shall be a switch at the door and one at the teaching station.
19. All classrooms, offices, lecture halls and most common areas shall utilize occupancy sensors. Our standard occupancy sensors are by Watt-Stopper, Sensor-Switch or Lutron. These sensors shall be wired downstream of light switch and set to turn lights if unoccupied for more than 20 minutes.
20. If natural light is abundant in the room then a daylight harvesting sensor shall be installed.
21. For larger classrooms with AV equipment the lighting scenes are typically setup as 1 – all lights on 100%, 2 – projector or overhead presentation where lights in room are dimmed down to about 50% and front row of lights are turned off, 3 – All lights set to 75%, 4- All lights set to 50%, 5 – All lights set to 20-30% and an off button. A Lutron system RS232 interface will be provided to tie the AV system and lighting control together.
22. For offices, open office areas, reception areas, lobby waiting areas, corridors with display areas, conference rooms and classrooms where LED lighting is used, provide 0-10V dimming.
23. Provide cut-sheets of all proposed light fixtures to KSU Office of the University Architect at DD submittal and CD submittal for review and approval.
24. Provide LEED design and documentation as required.
25. Design using the Illuminating Engineering Society (IES) Lighting Handbook as a guide for lighting levels. Design must also comply with energy conservation codes such as ASHRAE 90.1.
26. LED fixtures shall be specified unless special permission is granted.
27. Emergency lighting shall be provided for the following spaces listed below.
 - a. Corridors: Generator/night light or battery if no generator is available.
 - b. Stairs: 50% Battery with occupancy sensors to dim to 50% and 50% generator night light
 - c. Classrooms/lecture halls: 2x4's, 2x2's, downlights – integral battery. Specialty lighting or pendants separate emergency battery wallpack.

END OF SECTION 265119

SECTION 265213 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Lumen: Measured output of lamp and luminaire, or both.
- E. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.5 SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Certificates: For each type of luminaire.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Drivers: One for every 10 of each type and rating installed. Furnish at least one of each type.
 - 2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
 - 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
 - 5. Self-contained/unitized fixture: One complete replacement for every 10 luminaires provided.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 year(s) minimum from date of Substantial Completion.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Power Unit Batteries: Five years minimum from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with UL 1598 for fluorescent luminaires.
- F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.
- G. Bulb Shape: Complying with ANSI C79.1.
- H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
 - 1. Emergency Connection: Operate one driver continuously at an output of minimum 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects driver from battery, and battery is automatically recharged and floated on charger.

3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 - d. Altitude: Exceeding 3300 feet.
4. Nightlight Connection: Operate driver continuously at 40 percent minimum of rated light output.
5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Battery: Sealed, maintenance-free, nickel-cadmium type.
7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EMERGENCY LIGHTING

- A. Refer to Electrical Drawings for interior luminaire schedule.
- B. Emergency lighting shall be provided for the following spaces listed below.
 1. Corridors: Generator/night light or battery if no generator is available.
 2. Stairs: 50% Battery with occupancy sensors to dim to 50% and 50% generator night light.
 3. Classrooms/lecture halls: 2x4's, 2x2's, downlights – integral battery. Specialty lighting or pendants separate emergency battery wallpack.

2.3 MATERIALS

- A. Metal Parts:
 1. Free of burrs and sharp corners and edges.

2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Prismatic glass or Prismatic acrylic.
2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum housing and heat sink.
2. Painted finish.

2.4 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service:
 - 1. Charge emergency power units and batteries minimum of 24 hours and conduct 90 minute discharge test.

3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 - 1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
 - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. Emergency lighting shall be provided per NFPA and as a minimum in a percentage of fixtures in all corridors stairwells, large lecture halls, public restrooms and other areas where you would have to pass through more than one door to exit into the egress corridor.

2. Emergency lighting shall consist of a percentage of fixtures tied into the building generator if one is available. These emergency fixtures would be circuited as a night light or through an emergency transfer device such as GTD-20 manufactured by Bodine.
3. A percentage of emergency lighting fixtures can also be comprised of stand alone light fixtures with integral battery backup. These devices shall have self diagnostics, a battery charging circuit and a push to test button. Lamp source shall be LED (Gilbert Inc). Emergency battery ballasts installed within light fixtures are acceptable where aesthetics is an issue, these shall be as manufactured by "Bodine".
4. All exit signs shall be L.E.D. type with integral battery charger, self testing diagnostics and a push to test button.
5. In applications where night light cannot remain energized, a GTD-20 may be used.
6. Provide LEED design and documentation as required.

END OF SECTION 265213

SECTION 265613 - LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Poles and accessories for support of luminaires.

1.3 DEFINITIONS

- A. EPA: Equivalent projected area.
- B. Luminaire: Complete luminaire.
- C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

1.4 SUBMITTALS

- A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.
 - 1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
 - 2. Include finishes for lighting poles and luminaire-supporting devices.
 - 3. Anchor bolts.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly of poles and pole accessories.
 - 4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
 - 5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
 - 6. Method and procedure of pole installation. Include manufacturer's written installations.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for foundation testing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.
 - 1. Warranty Period: Minimum of Five years from date of Substantial Completion.
 - 2. Warranty Period for Corrosion Resistance: Minimum of Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Minimum of Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design pole foundation and pole power system.
- B. Structural Characteristics: Comply with AASHTO LTS-6-M.
- C. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
- D. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.
- E. Ice Load: Load of 3 lbf/sq. ft., applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.
- F. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.
 - 1. Basic wind speed for calculating wind load for poles 50 feet high or less is 90 mph Insert value from AASHTO LTS-6-M for this Project.

- a. Wind Importance Factor: 1.0.
 - b. Minimum Design Life: 25 years.
 - c. Velocity Conversion Factor: 1.0.
- G. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.
- H. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 ALUMINUM POLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Cooper Lighting, an Eaton business.
 - 2. H.E. Williams.
 - 3. Hubbell Incorporated.
 - 4. KIM Lighting.
 - 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 6. LSI Industries.
 - 7. Valmont Industries
 - 8. Stresscrete Group
- B. Poles: Seamless, extruded structural tube complying with ASTM B 221, Alloy 6061-T6, with access handhole in in pole wall.
- 1. Shape: Square, straight
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Mast Arms: Aluminum type, continuously welded to pole attachment plate. Material and finish same as plate.
- D. Brackets for Luminaires: Detachable, cantilever, without underbrace.
- 1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with stainless-steel bolts.
 - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.
- E. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- F. Grounding and Bonding Lugs: Bolted 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- G. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- H. Handhole: Rectangular shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
- I. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- J. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.
 4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
- K. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 2. Powder coat shall comply with AAMA 2604.
 - a. Electrostatic applied powder coating; single application with a minimum 2.5- to 3.5-mils dry film thickness; cured according to manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.
 - b. Color: As selected by Architect from manufacturer's full range.

2.3 PRESTRESSED CONCRETE POLES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Stresscrete Group, King Luminaire (Pole standard KSU), Eclipse Black color with etched finish.
- B. Poles: Comply with ASTM C 1089 and manufactured by centrifugal spin-casting process.

- C. Shape: Fluted.
- D. Mounting Provisions: Continuous precast direct bury.
- E. Finishing: Capped at top and plugged at bottom. Seat each reinforcing strand with epoxy adhesive.
- F. Grounding: Continuous copper ground wire cast into pole. Terminate at top of pole.
- G. Raceway: Smooth, internal, and not less than 3 inches in diameter.
- H. Concrete: Minimum 28-day compressive strength of 7000 psi.
- I. Cured with wet steam and aged for a minimum of 15 days prior to installation.
- J. Reinforcement: Pre-stressing strand, 270 K, complying with ASTM A 416/A 416M.
- K. Surface Treatment: Hard, nonporous, and resistant to water, frost, and road and soil chemicals; and shall have a maximum water-absorption rate of 3 percent.
- L. Finish Texture: Etched exposed aggregate.
- M. Exposed aggregate shall be of type.
- N. Fasteners: Stainless steel, size and type as determined by manufacturer. Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
- O. Nameplate: Aluminum cast into pole wall at approximately 5 feet above ground line, listing name of manufacturer, Project identifier, overall height, and approximate weight.
- P. Pole Brackets: Comply with ANSI C136.31.

2.4 POLE ACCESSORIES

- A. Duplex Receptacle: Ground-fault circuit interrupter type, 120 V ac, 20 A in a weatherproof assembly. Comply with requirements in Section 262726 "Wiring Devices."
 - 1. Recessed 12 inches above finished grade.
 - a. NEMA 250, Type 4X, nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.
 - b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.
- B. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.
- C. Decorative accessories, supplied by decorative pole manufacturer, include the following:
 - 1. Banner Arms: As indicated on drawing.

2.5 MOUNTING HARDWARE

- A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi.
 - 1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
 - 2. Threading: Uniform National Coarse, Class 2A.
- B. Nuts: ASTM A 563, Grade A, Heavy-Hex
 - 1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
 - 2. Four nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.
- C. Washers: ASTM F 436, Type 1.
 - 1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
 - 2. Two washers provided per anchor bolt.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine poles, luminaire-mounting devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.
- C. Examine roughing-in for foundation and conduit to verify actual locations of installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE FOUNDATION

- A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and

strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

- B. Pre-Cast Foundations: Factory fabricated, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- C. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.
 - 1. Baseplate: Stamped with manufacturer's name, date of production, and cable entry.
- D. Direct-Buried Foundations: Install to depth indicated on Drawings, but not less than as indicated. Add backfill in 6-inch to 9-inch layers, tamping each layer before adding the next as shown on Drawings. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.
- E. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than as indicated. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.
 - 1. Make holes 6 inches in diameter larger than pole diameter.
 - 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days and finish in a dome above finished grade.
 - 3. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
 - 4. Cure concrete a minimum of 72 hours before performing work on pole.
- F. Anchor Bolts: Install plumb using manufacturer-supplied steel template, uniformly spaced.

3.3 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
 - 1. Fire Hydrants and Water Piping: 60 inches.
 - 2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
 - 3. Trees: 15 feet from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

- D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers unless otherwise indicated.
 - 4. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.
- F. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.
- B. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.5 GROUNDING

- A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundation.

3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
1. Inspect poles for nicks, mars, dents, scratches, and other damage.
 2. System function tests.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
1. Poles shall be limited to 35' in height including base.
 2. Pole/fixture location shall be such that servicing is made possible, glare into adjacent windows is avoided and light spillage to adjacent areas (wetlands, greenhouses, etc..) is avoided.
 3. KSU typically installs an in-ground pullbox at each pole/fixture location. All splices within the in-ground pullboxes shall be made watertight with gel filled enclosures.
 4. Spun reinforced concrete poles with integral bases are preferred (StressCrete). All fasteners shall be torqued and coated with thread locking compound (Loctite).
 5. Aluminum poles are permitted. Aluminum poles shall have vibration dampeners. KSU does not permit the use of fiberglass poles or hinged poles.
 6. Refer to appendix 265619, KSU pole details.
 7. Any convenience receptacles located in or near outdoor fixtures or on poles must be GFCI protected and approved for wet location with a hinged cover and shall be painted to match the surface in which they are mounted. The convenience receptacles are to be energized continuously and not be connected to a lighting contactor.
 8. In designated areas Kent State standard permits fluted formed aluminum pole with 2 piece base, Stresscrete KSB19-FF-A-18.

END OF SECTION 265613

SECTION 265619 – LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
- 2. Luminaire supports.

B. Related Requirements:

- 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
- 2. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS

- A. Product Data: For each type of luminaire.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaire.
 - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.

5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.
 1. Provide a manufacturers cutsheets including replacement parts list, color temperature, lumen output, and optical pattern for all types used on Project. Use ANSI and manufacturers' codes.
 2. Include all manufacturers' warranty information.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Drivers: One for every 10 of each type and rating installed. Furnish at least one of each type.
 2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 10 of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.

- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.9 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 5 year(s) minimum from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product or its listed engineer's approved equivalent product indicated on drawings.

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. CRI of minimum 80. CCT of 4000 K.
- F. L70 lamp life of 50,000 hours.
- G. Dimmable from 100 percent to 10 percent of maximum light output.
- H. Internal driver.
- I. Retain "In-line Fusing" Paragraph below when an integral fuse is desired. Coordinate with the Exterior Luminaire Schedule on Drawings.
- J. In-line Fusing: Single fuse for 120V & 277V and two fuses for 208V and 480V on the primary for each luminaire.

2.3 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.
- C. Diffusers:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- E. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- F. Housings:
 - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide filter/breather for enclosed luminaires.

2.4 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
 - a. Color: Determined by Architect.
- D. Factory-Applied Finish for Steel luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range.

2.5 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install drivers for each luminaire.
- C. Fasten luminaire to structural support.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Support luminaires without causing deflection of finished surface.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
- F. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.
- H. Coordinate layout and installation of luminaires with other construction.
- I. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the IES testing guide(s).
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Architect.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
1. Design using the Illuminating Engineering Society (IES) Lighting Handbook as a guide for lighting levels. Design must also comply with energy conservation codes such as ASHRAE 90.1. plus 20% more efficiency. Provide point by point photometric calculations to the KSU Office of the University Architect to review at DD submittal and CD submittal.
 - a. Primary Walkways – 2FC avg., 0.5 FC min.
 - b. Secondary Walkways – 1FC avg., 0.25FC min
 - c. Primary Streets - 2FC avg., 0.677FC min.
 - d. Parking Lots – 1FC avg., 0.25FC min.
 - e. High Activity Outdoor Parking 2.4FC avg., 0.6FC min.
 2. KSU's standard light source for exterior lighting is LED.
 3. KSU prefers to control outdoor lighting via photocell to a contactor with a hand/off/auto selector switch. An astronomic time clock can be used for control of accent lighting but not for security lighting.
 4. In special cases it may be suggested to utilize the Kent State University Building Automation and Control System (Johnson Controls) contacts to interface the lighting control system allowing BACC to override and/or load shed non-emergency exterior lighting.
 5. All new lighting contactors shall have Hand/Off/Auto Switches with pilot lights.
 6. Typically utilize 277V for exterior lighting.
 7. Poles shall be limited to 35' in height including base.
 8. Pole/fixture location shall be such that servicing is made possible, glare into adjacent windows is avoided and light spillage to adjacent areas (wetlands, greenhouses, etc.) is avoided.
 9. KSU does **not** allow in-ground fixtures in paved/concrete walkway areas (sidewalks, driveways, patio, etc.) however they may be used sparingly in landscaped bed areas with permission.
 10. KSU typically installs an in-ground pullbox at each pole/fixture location. All splices within the in-ground pullboxes shall be made watertight with gel filled enclosures.
 11. KSU standard area light is Lithonia DSX fixture 4000K.
 12. KSU standard outdoor general walkway lighting preference is a King Luminaire K118 with Stresscrete pole or King Luminaire K829 with Stresscrete Pole. Color temperature shall be 4000K. Type V distribution shall be the standard. Type III shall only be used if permitted by Electrical Engineer at KSU Office of the University Architect. Refer to KSU Standard details.
 13. Refer to specifications on conductors, cables and splicing requests for outdoor lighting feeders. KSU standard conduit is schedule 40 PVC buried 24" below finished grade with THWN insulated conductors. Conductors are to be sized for future growth and voltage drop calculations.
 14. Spun reinforced concrete poles with integral bases are preferred (StressCrete). Aluminum and steel poles are permitted. Aluminum and steel poles shall have vibration dampeners. KSU does not permit the use of fiberglass poles or hinged poles.
 15. Refer to appendix 265619, KSU pole details.

16. Provide LEED design and documentation as required.
17. Any convenience receptacles located in or near outdoor fixtures or on poles must be GFCI protected and approved for wet location with a hinged cover and shall be painted to match the surface in which they are mounted. The convenience receptacles are to be energized continuously and not be connected to a lighting contactor.

END OF SECTION 265619

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding labeling.

1.3 DEFINITIONS

- A. ACEG: Alternating Current Equipment Ground
- B. BC: Bonding Conductor
- C. BCT: Bonding Conductor for Telecommunications.
- D. BS: Building Steel
- E. EMT: Electrical Metallic Tubing.
- F. GE: Grounding Equalizer
- G. TBB: Telecommunications Bonding Backbone
- H. TGB: Telecommunications Grounding Busbar
- I. TEBC: Telecommunications Equipment Bonding Conductor
- J. TER: Telecommunications Equipment Room
- K. TMGB: Telecommunications Main Grounding Busbar.
- L. TR: Telecommunications Room
- M. WL: Wire Ladder Pathway

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.
- C. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. BCT, TMGB, TGBs, and routing of their bonding conductors.
- D. Qualification Data: For installation supervisor.
- E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Result of the ground-resistance test, measured at the point of BCT connection.
 - b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of telecom cabling technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with TIA-607-B.

2.2 CONDUCTORS

- A. Comply with UL 486A-486B.
- B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: No. 6 AWG.
 - 3. Ground wire for main connections to electrical service, local electrical panel and building steel shall be no. 2 AWG THHN insulated wire.
- C. Cable Tray Grounding Jumper:
 - 1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

2.3 CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Chatsworth.
 - 2. Erico
 - 3. Hubbell
 - 4. Panduit
- B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.
- D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
- E. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
- F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chatsworth Products, Inc
 - 2. Cooper B-Line
 - 3. Panduit Corp
 - 4. Hubbell
- B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

2.5 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607-B.

3.3 APPLICATION

- A. Conductors: Install stranded conductors for all grounding.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 2 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 2 AWG.
- B. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Structural Steel: Welded connectors.
- C. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches.
- D. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.
 - 4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 2 AWG.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pretwist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than No. 2 AWG conductor.
- F. Telecommunications Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with integral the busbar or bonding lug. Bond the equipment grounding busbar to the TGB No. 6 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame with No.2 AWG.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard with No.2 AWG.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Access Floors: Bond all metal parts of access floors to the TGB.
- L. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.
 - 1. Install the conductors in grid pattern on 4-foot centers, allowing bonding of one pedestal from each access floor tile.
 - 2. Bond the TGB of the equipment room to the reference grid at two or more locations.
 - 3. Bond all conduits and piping entering the equipment room to the TGB at the perimeter of the room.

3.7 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
 - 2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
 - 3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.
- C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable innerduct pathways and fittings.
4. Flexible textile innerduct pathways placed within conduits.
5. Metal wireways and auxiliary gutters.
6. Nonmetallic wireways and auxiliary gutters.
7. Metallic surface pathways.
8. Nonmetallic surface pathways.
9. Tele-power poles.
10. J-Hooks.
11. Boxes, enclosures, and cabinets.
12. Polymer-concrete handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RTRC: Reinforced thermosetting resin conduit.

1.4 SUBMITTALS

- A. Product data for the following:
 1. Surface pathways
 2. Wireways and fittings.
 3. Tele-power poles.
 4. Boxes, enclosures, and cabinets.
 5. Underground handholes and boxes.

- B. Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Alpha Wire.
 - 4. Anamet Electrical, Inc.
 - 5. Electri-Flex Company.
 - 6. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 7. Picoma Industries, Inc.
 - 8. Plasti-Bond.
 - 9. Republic Conduit.
 - 10. Southwire Company.
 - 11. Thomas & Betts Corporation; A Member of the ABB Group.
 - 12. Western Tube and Conduit Corporation.
 - 13. Wheatland Tube Company.
- C. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. ARC: Comply with ANSI C80.5 and UL 6A.
- F. PVC-Coated Steel Conduit: PVC-coated GRC.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel

- b. Type: Set screw.
- 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Anamet Electrical, Inc.
 - 4. Arnco Corporation.
 - 5. CANTEX INC.
 - 6. Carlon; a brand of Thomas & Betts Corporation.
 - 7. CertainTeed Corporation.
 - 8. Condux International, Inc.
 - 9. Dura-Line.
 - 10. Electri-Flex Company.
 - 11. Kraloy.
 - 12. Lamson & Sessions.
 - 13. Niedax Inc.
 - 14. RACO; Hubbell.
 - 15. Thomas & Betts Corporation; A Member of the ABB Group.
- C. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. Rigid HDPE: Comply with UL 651A.
- F. Continuous HDPE: Comply with UL 651A.
- G. RTRC: Comply with UL 2515A and NEMA TC 14.

- H. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL-FIBER-CABLE INNERDUCT PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway (innerduct) with a circular cross section, approved for plenum and riser installation unless otherwise indicated.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alpha Wire.
 - 2. Carlon; a brand of Thomas & Betts Corporation.
 - 3. Dura-Line.
 - 4. Endot Industries Inc.
 - 5. IPEX USA LLC.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

2.4 FLEXIBLE TEXTILE INNERDUCT PATHWAYS PLACED WITHIN CONDUITS

- A. Description: Flexible Textile Innerduct to be placed within conduits for the purpose of installing optical-fiber-cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

MaxCell Group/TVC Communications
600 Plum Creek Dr. Wadsworth, OH. 44281
1-888-387-3828

- C. MATERIALS

- 1. White Polyester and Nylon resin polymer

- D. TEXTILE INNERDUCT

- 1. Detectable Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape, and a solid copper, polyvinyl color coated conductor (19AWG minimum) for tracing and rated for a minimum of 6 amps and 600 volts. Conductor shall be placed in the sidewall edge fold of the textile sleeve.
 - 2. Indoor Textile Innerduct (Riser-listed): Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.

E. TEXTILE INNERDUCT FITTINGS

1. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.: a. 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
2. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit, Raychem Inflata-Seals.

F. PULL TAPE

1. Pull Tape: measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.

2.5 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. B-line, an Eaton business.
 2. Hoffman; a brand of nVent.
 3. MonoSystems, Inc.
 4. Square D; by Schneider Electric.
- C. General Requirements for Metal Wireways and Auxiliary Gutters:
 1. Comply with UL 870 and NEMA 250, Type 1 and/or Type 3R unless otherwise indicated, and sized according to NFPA 70.
 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 3. Comply with TIA-569-D.
- D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: Hinged type unless otherwise indicated.
- F. Finish: Manufacturer's standard enamel finish.

2.6 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Moulded Products, Inc.
 - 2. Carlon; a brand of Thomas & Betts Corporation.
 - 3. Hoffman; a brand of nVent.
 - 4. Niedax Inc.
- C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

2.7 SURFACE METAL PATHWAYS

- A. Description: Galvanized steel with snap-on covers, complying with UL 5.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. MonoSystems, Inc.
 - 2. Niedax Inc.
 - 3. Panduit Corp.
 - 4. Wiremold / Legrand.
- C. Finish: Manufacturer's standard enamel finish in color selected by Architect.
- D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- E. Comply with TIA-569-D.

2.8 SURFACE NONMETALLIC PATHWAYS:

- A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carlon; a brand of Thomas & Betts Corporation.
 - 2. MonoSystems, Inc.
 - 3. Panduit Corp.
 - 4. Quazite: Hubbell Power Systems, Inc.
 - 5. Wiremold / Legrand.

- C. Finish: Texture and color selected by Architect from manufacturer's standard colors.
- D. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
- E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- F. Comply with TIA-569-D.

2.9 TELE-POWER POLES:

- A. Description: Prefabricated, finished metal pole with prewired power and communications outlets.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. MonoSystems, Inc.
 - 2. Panduit Corp.
 - 3. Wiremold / Legrand.
- C. Material: Galvanized steel with ivory baked-enamel finish or as specified on drawings. .
- D. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.
- E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- F. Comply with TIA-569-D.

2.10 J-HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. MonoSystems, Inc.
 - 2. Panduit Corp.
 - 3. Wiremold / Legrand.
 - 4. Erico (Caddy Clip)
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.
- E. Galvanized steel

1. Non-metallic J-hooks will not be acceptable.

F. J shape.

2.11 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FSR Inc.
2. Hoffman; a brand of nVent.
3. RACO; Hubbell.
4. RANDL
5. Thomas & Betts Corporation; A Member of the ABB Group.
6. Wiremold / Legrand.

C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 5 inches square by 2-7/8 inches deep.

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

F. Metal Floor Boxes:

1. Material: Cast metal for on-grade or sheet metal for above grade.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 and/or Type 3R, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:
 - a. Material: Plastic.

- b. Finished inside with radio-frequency-resistant paint.
- 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.12 POLYMER-CONCRETE HANDHOLES

- A. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armorcast Products Company.
 - 2. NewBasis.
 - 3. Oldcastle Precast, Inc.
 - 4. Quazite: Hubbell Power Systems, Inc.
- C. General Requirements for Polymer Concrete Handholes:
 - 1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D and SCTE 77.
- D. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
- E. Cover: Weatherproof, structural load rating consistent with enclosure and handhole location. Concrete rated up 20,000 lb secured with stainless steel bolts.
 - 1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 2. Cover Legend: Molded lettering, "COMMUNICATIONS".
- F. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- G. Handholes: 12 inches wide by 24 inches long or larger.

2.13 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: GRC.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC,.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
 - 5. Flexible textile innerduct pathways placed within conduits.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT or RNC.
 - 2. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Damp or Wet Locations: GRC or RNC
 - 5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT with flexible textile innerduct pathway.
 - 6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT with flexible textile innerduct pathway.
 - 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 1-1/4 inch trade size for horizontal copper cables, and 4" and larger for backbone unless noted otherwise on drawings.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use set-screw, steel fittings. Comply with NEMA FB 2.10.
- E. Install surface pathways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. All metal pathways shall be bonded. See detail notes and related specification sections for specifics.
- B. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- C. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- D. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- E. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- F. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- G. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- H. Complete pathway installation before starting conductor installation.
- I. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- J. Install no more than the equivalent of two 90-degree bends in any pathway run.
- K. Support within 12 inches of changes in direction.

- L. All conduits bends shall have bend-radii of no less than 6X the outside diameter of conduit.
- M. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- N. Support conduit within 12 inches of enclosures to which attached.
- O. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 - 3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.
- P. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- Q. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- R. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- S. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- T. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- U. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- V. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- W. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- X. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- Y. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 1-1/4-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- Z. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- AA. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
 4. Refer to specification 270544, Sleeves and Sleeve Seals for communications pathway and cabling
- BB. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- CC. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

DD. J-Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 4 foot o.c., randomly spaced.
5. Provide a hook at each change in direction.
6. Grounding of J-Hooks
 - a. J-Hooks shall be bonded together with #12 awg.

EE. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

FF. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

GG. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

HH. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

II. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

JJ. Set metal floor boxes level and flush with finished floor surface.

KK. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe of less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete around conduit for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 - 1. Device backboxes Dimensions to be: 5 inches square by 2-7/8 inches deep with 1-1/4" grommets EMT to accessible area above finished ceiling. Bond to nearest telecom J-Hook or Cable Tray ground with 12 AWG.
 - 2. J-Hooks shall be bonded together with 12 awg.
 - 3. Size cable tray to support CAT6A cable with 50% growth.

END OF SECTION 270528

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Aluminum slotted support systems for communication raceways.
3. Nonmetallic slotted support systems for communication raceways.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

1.3 SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.

2. Steel slotted-channel systems.
3. Aluminum slotted-channel systems.
4. Nonmetallic slotted-channel systems.
5. Equipment supports.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. B-line, an Eaton business.
 - c. Flex-Strut Inc.
 - d. Gripple Inc.
 - e. GS Metals Corp.
 - f. G-Strut.
 - g. Haydon Corporation.
 - h. Metal Ties Innovation.
 - i. MIRO Industries.
 - j. Thomas & Betts Corporation; A Member of the ABB Group.
 - k. Unistrut; Part of Atkore International.
 - l. Wesanco, Inc.
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 4. Channel Width: Selected for applicable load criteria.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 9. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.
 2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) B-line, an Eaton business.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Use expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 270529

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wire-mesh cable tray.
 - 2. Cable tray accessories.
 - 3. Warning signs.
- B. Related Requirements:
 - 1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.3 SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray notes on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 WIRE-MESH CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. Chalfant Manufacturing Company.
 - 3. Chatsworth Products Inc (CPI)
 - 4. Cooper Industries; Cooper B-Line; GS Metals Corp.
 - 5. Cope Cable Tray; A Part of Atkore International.
 - 6. Enduro Composites Inc.
 - 7. Hubbell Incorporated; Wiring Device-Kellems.
 - 8. Legrand US.
 - 9. MonoSystems, Inc.
 - 10. MP Husky USA Cable Tray & Cable Bus.
 - 11. Niedax Inc.
 - 12. Snaketray.
 - 13. Vutec Corporation.
 - 14. WBT LLC.
- B. Description:
 - 1. Configuration: Galvanized- steel wire mesh, complying with NEMA VE 1.
 - 2. Width: As indicated on Drawings.
 - 3. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
 - 4. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.

5. Splicing Assemblies: Bolted type using serrated flange locknuts.
6. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

- a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
- b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
- c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
- d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.
 - 1) Hardware: Galvanized, ASTM B 633.
- e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A 653/A 653M, G90.
 - 1) Hardware: Galvanized, ASTM B 633.
- f. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.
 - 1) Hardware: Galvanized, ASTM B 633.

2.3 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

- A. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."
- B. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.5 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA FG 1.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding. Provide continuous bonding conductor, #6 awg or larger and bonded to each section.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Fasten cable tray supports to building structure.
- F. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems."
- G. Support tray per manufacturers maximum rating recommendations, no more than 6' oc.
- H. Transitions: Change of direction or elevation shall be achieved using one of the following methods:
 - 1. Incorporate pre-fabricated fittings to provide large bend radii and/or gradual elevation changes.
 - 2. Field-fabricated transitions providing large bend radii and/or gradual elevation changes using manufacture-recommended means and methods only.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Locate and install supports according to NEMA FG 1. Do not install more than one cable tray splice between supports.
- K. Support wire-basket cable trays from both sides with trapeze hangers or from beneath with wall brackets.
- L. Support trapeze hangers for wire-basket trays with minimum 1/4-inch- diameter rods.
- M. Do not use center-hung brackets. Center-hung tray will not be acceptable.
- N. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

- O. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.
- P. Make cable tray connections using manufacturer's recommended fittings.
- Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- S. Install cable trays with enough workspace to permit access for installing cables.
- T. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- U. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- V. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Provide continuous bonding conductor, #6 awg or larger and bonded to each section bonded to TGB in Telecom Room.

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on vertical runs to cable trays every 18 inches with Velcro strap 1" in width
- C. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- D. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorquing in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

3.6 PROTECTION

- A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 1. Size cable tray to support CAT6A cable with 50% growth.

END OF SECTION 270536

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduit and fittings, including GRC and PVC-coated GRC.
 - 2. Rigid nonmetallic duct.
 - 3. Duct accessories, including rigid innerduct and fabric innerduct.
 - 4. Polymer concrete handholes and boxes with polymer concrete cover.
 - 5. Precast manholes.
 - 6. Utility structure accessories.

1.3 DEFINITIONS

- A. Direct-Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
 - 2. Multiple duct banks.
- D. GRC: Galvanized rigid conduit.
- E. IMC: Intermediate metal conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 SUBMITTALS

- A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct and conduits and their accessories, including elbows, end bells, bends, fittings, duct spacers and solvent cement.
3. Include accessories for manholes, handholes, and boxes, and other utility structures.
4. Include underground-line warning tape.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:
 - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
 - b. Include duct entry provisions, including location and duct size.
 - c. Include reinforcement details.
 - d. Include frame and cover design and manhole chimneys.
 - e. Include ladder details.
 - f. Include grounding details.
 - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - h. Include joint details.
2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including location and duct size.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 MAINTENANCE MATERIALS SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Communications Service: Do not interrupt communications service to facilities occupied by Owner or others unless permitted under the following conditions, and then

only after arranging to provide temporary communications service according to requirements indicated:

1. Notify Kent State Engineer no fewer than two weeks in advance of proposed interruption of communications service.
2. Do not proceed with interruption of communications service without written permission from the Kent State Engineer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. PVC-Coated Steel Conduit: PVC-coated GRC.
 1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch, minimum.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AFC Cable Systems; a part of Atkore International.
 2. Allied Tube & Conduit; a part of Atkore International.
 3. Anamet Electrical, Inc.
 4. Calconduit.
 5. Electri-Flex Company.
 6. FSR Inc.
 7. Korkap.
 8. NEC, Inc.
 9. Opti-Com Manufacturing Network, Inc (OMNI).
 10. O-Z/Gedney; a brand of Emerson Industrial Automation.
 11. Perma-Cote.
 12. Picoma Industries, Inc.
 13. Plasti-Bond.
 14. Republic Conduit.
 15. Southwire Company.
 16. Thomas & Betts Corporation; A Member of the ABB Group.
 17. Topaz Electric; a division of Topaz Lighting Corp.
 18. Western Tube and Conduit Corporation.
 19. Wheatland Tube Company.
- D. General Requirements for Metal Conduits and Fittings:
 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 2. Comply with TIA-569-C and TIA-758-C.

2.2 RIGID NONMETALLIC DUCTS

- A. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Underground Plastic Utilities Duct: Type DB-60-PVC and Type DB-120-PVC RNC, complying with NEMA TC 6 & 8 and with ASTM F-512 for direct burial, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.
- C. Underground Plastic Utilities Duct: Type EB-20 PVC RNC, complying with NEMA TC 6 & 8, ASTM F-512, and UL 651, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. CANTEX INC.
 - 4. CertainTeed Corporation.
 - 5. Condux International, Inc.
 - 6. Crown Line Plastics.
 - 7. ElecSys, Inc.
 - 8. Electri-Flex Company.
 - 9. Endot Industries Inc.
 - 10. IPEX USA LLC.
 - 11. Lamson & Sessions.
 - 12. Manhattan/CDT.
 - 13. National Pipe & Plastics.
 - 14. Opti-Com Manufacturing Network, Inc (OMNI).
 - 15. Spiraduct/AFC Cable Systems, Inc.
- E. General Requirements for Nonmetallic Ducts and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-C and TIA-758-C.

2.3 FLEXIBLE NONMETALLIC DUCTS

- A. HDPE Duct: Type EPEC 40-HDPE complying with NEMA TC 7 and UL 651A.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ARNCO Corp.
 - b. Carlon; a brand of Thomas & Betts Corporation.
 - c. National Pipe & Plastics.

- d. Opti-Com Manufacturing Network, Inc (OMNI).
- e. Premier Conduit.
- 2. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- 3. Comply with TIA-569-C and TIA-758-C.

2.4 DUCT ACCESSORIES

- A. Rigid Innerduct: Corrugated HDPE duct, orange in color, designed for installation within a duct or pathway.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Blue Diamond Industries.
 - b. Carlon; a brand of Thomas & Betts Corporation.
 - c. Dura-Line.
 - d. Eastern Wire.
 - e. Endot Industries Inc.
 - f. Opti-Com Manufacturing Network, Inc (OMNI).
 - g. Premier Conduit.
 - h. Thomas & Betts Corporation; A Member of the ABB Group.
- B. Fabric Innerduct: Continuous, polyester, multi-pocket fabric innerduct, with internal pull tape and tracer wire.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Maxcell.
- C. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. CANTEX INC.
 - c. Carlon; a brand of Thomas & Betts Corporation.
 - d. IPEX USA LLC.
 - e. PenCell Plastics.
 - f. Underground Devices, Inc.
- D. Underground-Line Warning Tape: Underground-line warning tape specified in Section 270553 "Identification for Communications Systems."

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armorcast Products Company.
 - 2. MacLean Highline.
 - 3. NewBasis.
 - 4. Oldcastle Enclosure Solutions.
 - 5. Quazite: Hubbell Power Systems, Inc.
 - 6. Carlisle Syntec
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray.
- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "COMMUNICATIONS."
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes: Minimum 12 inches wide by 24 inches long.

2.6 PRECAST MANHOLES

- A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.

4. Lindsey Concrete
 5. Oldcastle Precast, Inc.
 6. Rinker Group, Ltd.
 7. Riverton Concrete Products.
 8. Utility Concrete Products, LLC.
 9. Utility Vault Co.
 10. Wausau Tile Inc.
- C. Standard: Comply with ASTM C 858.
- D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
1. Type and size shall match fittings to duct or conduit to be terminated.
 2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.
- F. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct routed from the facility.
- G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.7 UTILITY STRUCTURE ACCESSORIES

- A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. BILCO Company (The).
 2. Campbell Foundry Company.
 3. Carder Concrete Products.
 4. Christy Concrete Products.
 5. EJ.
 6. Elmhurst-Chicago Stone Co.
 7. McKinley Iron Works, Inc.
 8. Neenah Foundry Company.
 9. NewBasis.
 10. Oldcastle Precast, Inc.
 11. Osburn Associates, Inc.
 12. Pennsylvania Insert Corporation.
 13. Quazite: Hubbell Power Systems, Inc.
 14. Rinker Group, Ltd.
 15. Riverton Concrete Products.

16. Underground Devices, Inc.
 17. Utility Concrete Products, LLC.
 18. Utility Vault Co.
 19. Wausau Tile Inc.
- C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B, with milled cover-to-frame bearing surfaces; 29-inch diameter.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 2. Cover Legend: Cast in. Selected to suit system.
 3. Manhole Chimney Components: Precast concrete rings, with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities of less than 2.0 cu. ft., where packaged mix complying with ASTM C 387, Type M, may be used.
 - b. Seal joints watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.
- D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.
1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.
- G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to a minimum of 1-1/4 inches at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- I. Ground Rod Sleeve: 3-inch, PVC duct sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

- J. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip, with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- K. Cable Rack Assembly: Refer to detail on drawings.
- L. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Communications: Type EPC-40-PVC RNC, in concrete-encased duct bank unless otherwise indicated.

- B. Duct for Communications: Type EPC-80-PVC RNC, in direct-buried duct bank unless otherwise indicated.
- C. Duct for Communications: Type EPEC-40-HDPE duct in direct-bored duct bank unless otherwise indicated.
- D. Stub-Ups for Communications: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for Communications:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
 - 5. Cover design load shall not exceed the design load of the handhole or box.
- B. Manholes:
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area immediately after backfilling is completed or after construction in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.
- C. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward manholes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
 - 1. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings, and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End-Bell Entrances to Manholes: Use end bells, spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- H. Terminator Entrances to Manholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to terminator spacing 10 feet from the terminator without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch.

- I. Building Wall Penetrations: Make a transition from underground duct to appropriate raceway inside the building wall without reducing duct slope away from the building or forming a trap in the duct. Penetrations of building walls is specified in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."
- J. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use Raychem Inflata-Seals, system shall be capable to withstand at least 15psig hydrostatic pressure.
- K. Innerduct: Size and type as indicated on Drawings.
- L. Pulling Cord: Install 200-lbf-test nylon cord in empty duct and innerduct.
- M. Fabric innerduct: Use Maxell system.
- N. Concrete-Encased Duct and Duct Bank:
 - 1. Excavate trench bottom to provide firm and uniform support for duct or duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
 - 2. Width: Excavate trench 12 inches wider than duct or duct bank on each side.
 - 3. Width: Excavate trench 3 inches wider than duct or duct bank on each side.
 - 4. Depth: Install top of duct and duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 - 5. Support duct and duct bank on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - 6. Minimum Space Between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
 - 7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
 - 8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.
 - 9. Elbows: Use manufactured PVC Schedule 80 elbows for stub-ups, at building entrances, and at changes of direction in duct run. Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
 - 10. Reinforcement: Reinforce concrete-encased duct and duct bank where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - 11. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

12. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between ducts, and 4 inches between power and communications duct.
 13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
 14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between ducts and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto duct. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
- O. Underground-Line Warning Tape: Bury nonconducting underground-line warning tape specified in Section 270553 "Identification for Communication Systems" no less than 12 inches above all concrete-encased duct and duct bank and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
- P. Where ductbanks enter tunnels or buildings, provide Raychem Inflatable Seals.
- Q. Slope ductbanks away from tunnels and building entrances to prevent water infiltration.

3.6 INSTALLATION OF CONCRETE MANHOLES

- A. Precast Concrete Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, 57 limestone and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
 2. Manhole Frame: Set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - 2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
- E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing." Section 071354 "Thermoplastic Sheet Waterproofing.". After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After duct has been connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

3.7 INSTALLATION OF HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct and duct bank, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 57 limestone and compacted to same density as adjacent undisturbed earth.
- C. Elevation: Set cover flush with finished grade.
- D. Install handholes and boxes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.8 GROUNDING

- A. Ground underground duct, duct bank, and utility structures according to Section 270526 "Grounding and Bonding for Communications Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.
- B. Clean internal surfaces of manholes, including sump.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

PART 4 - KSU

- A. Do not locate handhole and manholes in roadways or paved areas.

END OF SECTION 270543

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

- B. Related Requirements:

- 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS**2.1 SLEEVES**

- A. Wall Sleeves:

- 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized-steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GPT Industries, Linkseal

2.3 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

- a. Seal annular space between sleeve and pathway using joint sealant appropriate for size, depth, and location of joint. Joint sealant shall not be installed within pathway. Comply with requirements in Section 079200 "Joint Sealants."
- b. Seal space outside of sleeves with mortar or grout for less than 2" diameter, use Linkseals for 2" or greater. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Space between cable and interior sleeve:

- a. Above grade interior penetration for fire and acoustical rated walls and floors: Hilti firestop plug CFS-PL.
- b. Below grade exterior penetration: Raychem RDSS Rayflate duct sealing system.
- c. Above grade interior environmental (warm to cold location, non-conditioned and conditioned spaces, pressurized spaces): Hilti firestop plug CFS-PL.

3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
4. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
5. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
6. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed. Sleeves over 6'-0" shall be provided with insulated ground bushings both ends.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Color and legend requirements for labels and signs.
2. Labels.
3. Bands and tubes.
4. Signs.
5. Cable ties.

1.3 SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

- B. Identification Schedule:

1. Outlets: Scaled drawings indicating location and proposed designation.
2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
3. Racks: Scaled drawings indicating location and proposed designation.
4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Champion America.
 - c. Grafoplast Wire Markers.
 - d. HellermannTyton.
 - e. LEM Products Inc.
 - f. Marking Services, Inc.
 - g. Panduit Corp.
 - h. Seton Identification Products.

- B. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester flexible labels with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A'n D Cable Products.
 - b. Brady Corporation.
 - c. Brother International Corporation.
 - d. emedco.
 - e. Grafoplast Wire Markers.
 - f. Ideal Industries, Inc.
 - g. LEM Products Inc.
 - h. Marking Services, Inc.
 - i. Panduit Corp.
 - j. Seton Identification Products.
2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
3. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

- C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A'n D Cable Products.
 - b. Brady Corporation.
 - c. Brother International Corporation.
 - d. emedco.
 - e. Grafoplast Wire Markers.
 - f. HellermannTyton.
 - g. Ideal Industries, Inc.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Panduit Corp.
 - k. Seton Identification Products.
 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Ideal Industries, Inc.
 3. LEM Products Inc.
 4. Marking Services, Inc.
 5. Reef Industries, Inc.
 6. Seton Identification Products.
- B. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- C. Color and Printing:
1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
 2. Inscriptions for Orange-Colored Tapes: "OPTICAL-FIBER CABLE".
- D. Tag: Type IID:

1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Overall Thickness: 8 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 34 lb/1000 sq. ft..
6. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.

2.5 SIGNS

A. Laminated-Acrylic or Melamine-Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.
 - d. Marking Services, Inc.
2. Engraved legend.
3. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 CABLE TIES

A. Description: Cable ties utilized to fasten labels and tags to backbone cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Marking Services, Inc.
4. Panduit Corp.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 7000 psi.

3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- H. Vinyl Wraparound Labels:
 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
3. Provide label 6 inches from cable end.

I. Self-Adhesive Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

J. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

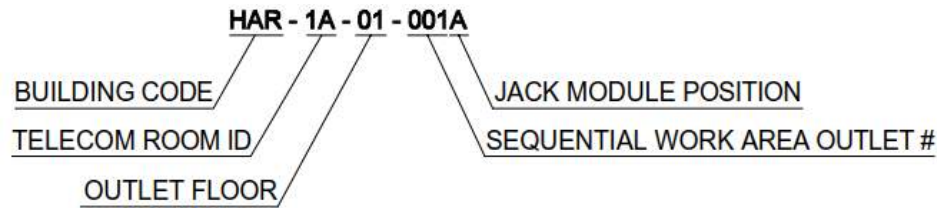
K. Underground-Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Limit use of underground-line warning tape to direct-buried cables.

3.3 IDENTIFICATION SCHEDULE

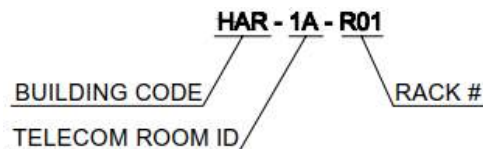
- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
1. System legends shall be as follows:
 - a. Telecommunications.
- D. Faceplates: Label individual faceplates with mechanically-printed labels. Place label behind label window on faceplate. Each faceplate shall be labeled with its unique alphanumeric designation composed of the following, in the order listed:
1. 3-Digit Building designation (confirm with Owner).
 2. 2-Digit Telecom room designation (confirm with Owner).
 3. 2-Digit Work area outlet's floor.
 4. Three digit sequence to represent faceplate (e.g. "001", "002", "003", etc.) and letter to designate.
 5. Jack position (e.g. A, B, C, or D).

6. Example: The example faceplate label below indicates a faceplate located on the first floor of Harbourt Hall containing a jack module connected to telecom room “1A” and terminated on patch panel port “001A”.

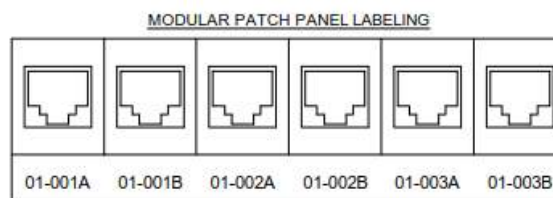


E. Equipment Room Labeling:

1. Racks: Identify front of each rack on top rail with nylon plates embossed with rack label.
 - a. Building designation (confirm with Owner)
 - b. Telecom room designation.
 - c. Rack number.
 - d. Example: The example rack label below indicates the first rack located in telecom room “1A” in Harbourt Hall.



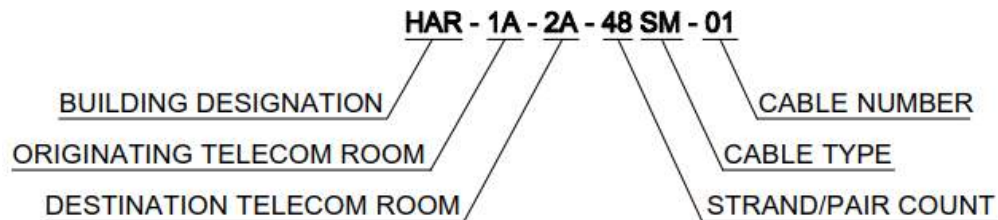
2. Patch Panels: Label each patch panel port with a mechanically produced label with the terminating cable’s faceplate identifier:
 - a. Two digit work area outlets floor.
 - b. Three digit work area outlet number (sequence to reflect corresponding faceplate label) + letter to designate jack position.
 - c. Example: The example patch panel port label below indicates a port terminating the cable from floor 01 jack, position “A” located in work area outlet “001.”



F. Backbone:

1. Intra-building backbone cable

- a. 3-Digit Building designation.
- b. Origination Telecom Room.
- c. Destination Telecom Room.
- d. Strand-count + Type: e.g. "SM" (singlemode fiber), "MM" (multimode fiber), "C3" (CAT3).
- e. 2-digit sequential cable number (e.g. 01, 02.. etc)
- f. Example: The example backbone cable label below indicates the first 48-strand singlemode fiber optic cable originating in closet "1A" and terminating in closet "2A".



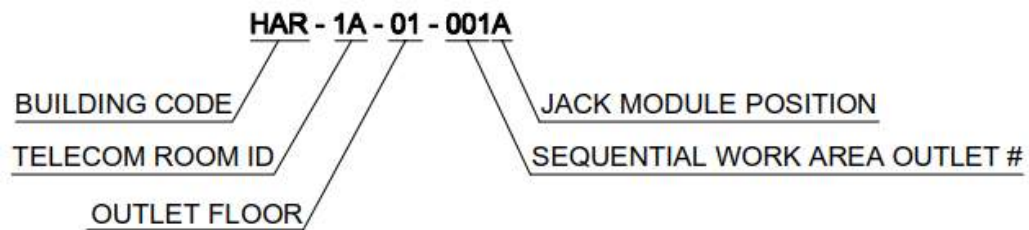
2. Inter-building backbone cable

- a. 3-Digit cable owner (i.e. KSU, ATT, TWC).
- b. 2-Digit cable type (i.e. Fb, Cu, Cx).
- c. Up to 10-Digit cable size (i.e. 100pr, RG11, OMM/65m, etc.).
- d. Occurrence of this cable (i.e. 1, 2, 3, etc.).
- e. End point #1 (i.e. Bldg. TLA, MH#, splice #, etc.).
- f. End point #2 (i.e. Bldg. MOU, MH#, splice #, etc.).
- g. Example: The example backbone cable label below indicates a Kent State University 48-strand singlemode fiber optic cable originating in Moulton Hall and terminating in the Library.



- G. Horizontal Cables: Label each cable with a vinyl-wraparound label indicating the following, in the order listed:

1. 3-Digit Building designation (confirm with Owner).
2. 2-Digit Telecom room designation (confirm with Owner).
3. 2-Digit Work area outlet's floor.
4. Three digit sequence to represent faceplate (e.g. "001", "002", "003", etc,) and letter to designate jack position (e.g. "A", "B", etc,)
5. Example: The example horizontal cable label below indicates a cable originating from patch panel port "001A" in Harbourt Hall telecom room "1A" connecting jack module "A" within work area outlet "001" located on floor "01".



- H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.
- I. Instructional Signs: Self-tapping.
- J. Equipment Identification Labels:
1. Equipment: Laminated-acrylic or melamine-plastic sign.
 2. Equipment to Be Labeled:
 - a. Racks

END OF SECTION 270553

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Backboards.

- B. Related Requirements:

- 1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
 - 2. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
 - 3. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
 - 4. Section 271333 "Communications Coaxial Backbone Cabling" for coaxial data cabling associated with system panels and devices.
 - 5. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
 - 6. Section 271533 "Communications Coaxial Horizontal Cabling" for coaxial data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. RCDD: Registered communications distribution designer.
- D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- E. TGB: Telecommunications grounding bus bar.
- F. TMGB: Telecommunications main grounding bus bar.

1.4 SUBMITTALS

- A. Product Data Sheet: For each type of product.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 - 2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 BACKBOARDS

- A. Backboards: Plywood, 3/4 by 48 by 96 inches, 4 ply, one side Grade A facing out, one side Grade C facing wall. Fire rated plywood is not permitted.
- B. Backboard Paint: Cover front, back, and all edges with gray fire-retardant paint.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for buried pathways.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in tracks and in room.

1. Meet jointly with Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 2. Record agreements reached in meetings and distribute them to other participants.
 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- G. Backboards:
1. Cover all walls with 3/4" plywood from 6 inches to 8 feet, 6 inches above finished floor.
 2. Paint all sides of backboard with two coats of fire-retardant paint.
 3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.
 4. Fire rated plywood is not permitted, all backboards shall be painted as described.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals." Telecom cabling contractor is responsible for firestopping between cables and sleeving.
- C. Comply with TIA-569-D, Annex A, "Firestopping."
- D. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices".
- E. Install firestop plugs (Hilti CFS-PL series or approved equal) on all conduit penetrations in telecom spaces.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.

1. Lighting fixtures are to be vaportight, 4' LED, 120 V, wet location, high impact lens fixtures, 70FC minimum. Fixtures installed behind and in front of equipment racks. Provide emergency power if available, or battery-operated wall pack in Telecom Room.
2. All Telecom Room walls covered with ¾" plywood painted with fire retardant paint.
3. All Telecom Rooms shall contain telecommunications grounding busbars (TGB) bonded to a telecommunications main grounding busbar (TMGB) with a #2AWG Telecommunications Bonding Backbone (TBB). Refer to specification section 270526 "Grounding and Bonding for Communication Systems".
4. Telecom Room shall not have ceiling/drop ceiling installed.
5. Provide a dedicated panelboard in each telecom room, minimum 100A, 208/120V, 3 phase, 4W, 30 CCT. With minimum thirty (30) 20A/1P circuit breakers unless noted otherwise on drawings.
6. Provide duplex receptacles with one dedicated 20A 120V circuit per rack. These should be on emergency power if available. Receptacles to be mounted on back of vertical wire management.
7. Provide duplex receptacles at 18" AFF at 8-ft centers around telecom rooms with minimum of two per wall.
8. Provide dedicated cooling on emergency power (if available).
9. Telecom Room shall be a minimum of 10' in width.
10. Telecom Room Length to be determined by the number of racks to be installed. For space planning purposes, a 19" equipment rack has a total rack width of 21.5".
11. A 6" vertical wire manager is required at each end of the rack row and between each rack.
12. Total Length of racks with vertical wire management in inches = (21.5 x Quantity of racks) + (6 x (1 + quantity of racks))
13. Total length of room equals Total Length of racks with wire management plus a minimum of 36".
14. The first rack will be the Infrastructure rack and be a 19" 4-post rack. The location of this rack is to be determined on a project basis.
15. Each TeleData horizontal cable rack shall terminate a maximum of 192 cables (have a maximum of 4 x 48 port patch panels).
16. Horizontal cables from different floor are not to be terminate on the same rack.
17. There shall be no cables in conduit in the Telecom Room. Stubs into the wall/floor/ceiling shall be provided and all cables within the closet shall be on ladder.

END OF SECTION 271100

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. 2-post 19-inch equipment racks.
3. 4-post 19-inch equipment racks.
4. Power strips.
5. Wire ladder pathways within telecom rooms.
6. Grounding.
7. Labeling.

B. Related Requirements:

1. Section 271110 "Communications Equipment Room Fittings" for backboards and accessories.
2. Section 270526 "Grounding and Bonding for Telecommunications Equipment" for TMGBs and TGBs.
3. Section 270536 "Cable Trays for Communications Systems" for cable trays and cable tray accessories.
4. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
5. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
6. Section 271333 "Communications Coaxial Backbone Cabling" for coaxial data cabling associated with system panels and devices.
7. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
8. Section 271533 "Communications Coaxial Horizontal Cabling" for coaxial data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. LAN: Local area network.
- C. RCDD: Registered communications distribution designer.

- D. TGB: Telecommunications grounding bus bar.
- E. TMGB: Telecommunications main grounding bus bar.

1.4 SUBMITTALS

- A. Product Data Sheet: For each type of product.
- B. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 - 2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 19-INCH EQUIPMENT RACKS

- A. Description: Two and four post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.
- B. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
 - 1. Chatsworth Products, Inc (CPI)
- C. General Requirements:
 - 1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Material: Extruded aluminum.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 - 4. Color: Black
- D. 2-Post Floor-Mounted Racks:
 - 1. Provide quantity per Project Drawings 2-post racks in new telecom rooms.
 - 2. Overall Height: 84 inches
 - 3. Color: Black
 - 4. Upright Depth: 3 inches

5. Load Rating: 1000 lb.
6. Number of Rack Units per Rack: 45
 - a. Numbering: Every rack unit, on interior of rack.
7. Threads: 12-24.
8. Base shall have a minimum of four mounting holes for permanent attachment to floor.
9. Top shall have provisions for attaching to cable tray or ceiling.
10. Manufacturer/Model: Chatsworth 46353-703.

E. 4-Post Floor-Mounted Racks:

1. Provide one 4-post rack (or quantity per Project Drawings) in each new telecom room.
2. Overall Height: 84 inches.
3. Color: Black
4. Load Rating: 2000 lb.
5. Number of Rack Units per Rack: 45
 - a. Numbering: Every rack unit, on interior of rack.
6. Threads: 12-24.
7. Base shall have a minimum of four mounting holes for permanent attachment to floor.
8. Top shall have provisions for attaching to cable tray or ceiling.
9. Manufacturer/Model: Chatsworth Quad-Rack 50120-703.
10. Metal, with integral wire retaining fingers.
11. Baked-polyester powder coat finish.
12. Color: Black
13. 6" wide vertical cable management panels shall have front channels, with covers.
14. Install 20" vertical wire ladder at rear of channel to serve as cable pathway between overhead wire ladder and termination panels.
15. Manufacturer/Model: Chatsworth 50120-703.

F. Vertical Wire Management Panel

1. A 6" vertical wire manager is required at each end of the rack row and between each rack.
2. Manufacturer/Model: Chatsworth 30092-703

G. Interbay Wire Management Panel

1. Equip each rack with the following (beginning at top of rack):
 - a. Rack Unit 45: 1RU Wire Manager: Chatsworth 30139-719
 - b. Rack Units 44 – 42: 3RU Wire Manager: Chatsworth 30131-719.
 - c. Above, below, and between copper termination panels: 2RU Wire Manager: Chatsworth 30130-719.

2.2 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Provide one at each vertical wire management panel vertically on wire ladder.
3. Each power strip shall have two independent circuits with 16 (NEMA 5-20R) outlets per circuit for a total of 32 outlets.
4. Metered.

5. Manufacturer/Model: Tripp-Lite PDUMV40

2.3 WIRE LADDER

- A. Install wire ladder in accordance to section 270536 "Cable Trays for Communication Systems".
- B. Provide overhead, wire ladder pathways to support all new cabling at 28% fill.
 - 1. Provide minimum 20" wire ladder pathway at 90'AFF around perimeter of room and above rack assembly.
 - 2. Minimize cable pathways to rack by connecting the overhead wire ladder pathway above rack assembly to the perimeter wire ladder with minimum 20" wire ladder. Two in front and two in rear.
 - 3. Use Chatsworth 11252-720 or as noted on Drawings.
- C. Provide minimum 12" wall-mounted wire ladder pathway on rear wall.
 - 1. One horizontal wire ladder run the length of wall at 30'AFF to bottom of wire ladder.
 - 2. One vertical wire ladder run between the overhead wire ladder and the horizontal wire ladder.
 - 3. Provide vertical wire ladder pathway between all floor/wall conduit banks and the overhead wire ladder pathway.
 - a. Vertical wire ladder sized minimally to same width as conduit bank.
 - 4. Use Chatsworth 11252-712

2.4 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Integral rack grounding lug (located on rail upright) accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

2.5 LABELING

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Rack Labeling Scheme: Refer to 270553, Identification for Communication Systems.
- C. Label racks typically beginning at rack next to wall (as viewed from front of rack assembly). Confirm with KSU prior to final labeling.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in racks and room.
 - 1. Meet jointly with Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Clearances
 - 1. Provide 3.5-ft clearance in front and rear of rack assembly. Assuming 24"x24" plan view of rack.
 - 2. Notify Owner if clearances are not achievable.
- G. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

- A. Comply with NECA/BICSI 607.
- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.
- C. Bond all metallic telecom racking and pathways to TGB with #6 green.
- D. Bond wire ladder sections together with grounding jumpers to provide continuity through entire assembly.
- E. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards.
- C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration.
- D. Labels shall be machine printed. Type shall be 1/8 inch in height.

3.4 EQUIPMENT RACK OCCUPANCY

- A. Provide dedicated duplex receptacle on dedicated emergency circuit (if available) on back of each rack vertical with management, off-center at 18" AFF.
- B. Provide maximum of four (4) 48 port patch panels per rack.
- C. Terminate horizontal cables from different floors on separate racks.
- D. No more than 50% of rack shall be used, reserve 50% of rack for network electronic equipment.

END OF SECTION 271116

SECTION 271313 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. High-count Category 3 twisted pair cable.
 - 2. Connecting Hardware
 - 3. Lightning protection.
 - 4. Cabling identification.

1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. F/FTP: Overall foil screened cable with foil screened twisted pair.
- D. FTP: Shielded twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- H. LAN: Local area network.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. S/FTP: Overall braid screened cable with foil screened twisted pair.
- M. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER BACKBONE CABLING DESCRIPTION

- A. Copper backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 SUBMITTALS

- A. Product Data Sheet: For each type of product.
- B. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as a Technician to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685.
 - 2. Communications, Riser Rated: Type CMR complying with UL 1666.

2.3 HIGH-COUNT CATEGORY 3 TWISTED PAIR CABLE

- A. Description: pair-count as indicated on Drawings, balanced-twisted pair cable, certified to meet transmission characteristics of Category 3 cable at frequencies up to 16MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by the following [provide products by one of the following]:
 - 1. Belden.
 - 2. Berk-Tek.
 - 3. Commscope.
 - 4. General.
 - 5. Superior Essex.
- C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 3 cables.
- D. Conductors: 100-ohm, 24 AWG solid copper.
- E. Cable Rating: As indicated by environment in which cable is placed.

2.4 CONNECTING HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Cable Connecting Hardware:
 - 1. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.

2. Cables shall be terminated with connecting hardware of same category or higher.

C. Patch Panel:

1. 48-port Category 3 or 5e.
2. Terminate 50-pr on patch panel.
 - a. 1-pair per port.
 - b. Spare out violet/slate pair.

2.5 LIGHTNING PROTECTION

- A. All inter-building copper backbone cabling must have lightning protection at both ends.
1. Manufacture/Model: Circa 1880ENA1/NSC.
 2. Solid state modules must be used.

2.6 CABLING IDENTIFICATION

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding" for grounding conductors and connectors.
- B. Telecommunication contractor is responsible for between rack, ladder rack, telecom equipment to the TMG or TMBG. In addition, lightning protection for telecom grounding by telecommunication contractor.
- C. Comply with TIA-607-B.

PART 3 - EXECUTION

3.1 INSTALLATION OF COPPER BACKBONE CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM)," Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 3. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.

4. Terminate all conductors; no cable shall contain unterminated elements, unless specified elsewhere. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports at random distances not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 10 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.2 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping." Refer to Electrical and Communications specifications when added.
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.3 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-B and NECA/BICSI-607.
- C. Bond lighting protection to the grounding bus bar (TMB or TMGB), using not smaller than a No. 6 AWG grounding conductor.

3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 1. Administration Class: 3.

- B. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling" for cable and asset management software.
- C. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- D. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test 100% of cable pairs.
 - 4. Tests (provide summary of detailed tests listed below on company letterhead):
 - a. Length
 - b. Wire map test
 - c. Continuity
 - d. Shorts
 - e. Opens
 - f. Reversed pairs
 - g. Split pairs
 - h. Other miswiring
 - i. Crossed pairs

- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare tests in report summary for on Contractor's company letterhead.

END OF SECTION 271313

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. 9/125 micrometer single-mode, indoor-outdoor optical fiber cable (OS2).
 - 2. Optical fiber cable termination equipment and patch panels.
 - 3. Cabling identification products.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

- A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, patch panels, pigtail connectors, and splice cases.

1.5 SUBMITTALS

- A. Product Data Sheet: For each type of product.
- B. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and, Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Technician who shall be present at all times when Work of this Section is performed at Project site.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD and Technician.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 1. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

- A. Description: Single mode, 9/125-micrometer,, single loose tube, optical fiber cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Belden CDT Networking Division/NORDX.
 2. Berk-Tek Leviton; a Nexans/Leviton alliance.
 3. CommScope, Inc.
 4. Corning.
 5. General.
 6. Superior Essex Inc.

C. Standards:

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

E. Jacket:

1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
2. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
3. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.

2.3 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Berk-Tek Leviton; a Nexans/Leviton alliance.

B. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

C. Patch Panels:

1. Contain multiple adapter-plate openings.
2. Provide panel with sufficient adapter-plate openings to support all incoming campus and intra-building fiber strands.
3. Manufacturer/Model:
 - a. 1-24 Strands Leviton 1RU 1000i SDX enclosure #5R1UM-S03.
 - b. 25-72 Strands Leviton 2RU 1000i SDX enclosure #5R2UM-S06.
 - c. Above 73 Strands Leviton 3RU 1000i SDX enclosure #5R3UM-F12

D. Adapter Plates:

1. Manufacturer/Model: Leviton 12 Fiber SDX adapter plate 0S2, Duplex LC Blue #5F100-2LL
2. Leviton blank adapter plate #5F100-PLT

E. Connectorized Pigtails

1. 12 Strand individual color coded pigtail kit 3M #UPPLC-KIT

2.4 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

- B. Comply with TIA-607-B.

2.5 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.
- B. General Requirements for Optical Fiber Cabling Installation:
 - 1. Comply with TIA-568-C.1 and TIA-568-C.3.
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

9. In the communications equipment room, provide a minimum 10-foot- long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Cable installed under raised flooring shall be protected in innerduct.

E. Group connecting hardware for cables into separate logical fields. Cable from different locations shall terminate in separate individual enclosures.

3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 1. Administration Class: Class 3.
- B. Cable and Wire Identification:
 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 3. Label each unit and field within distribution racks and frames.
 4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.
- C. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Fiber Optic Backbone Cable:

1. It is Kent State University's standard to test all fiber optic cable strands for continuity and attenuation utilizing a Fiber Optic Time Domain Reflectometer (OTDR).
2. Singlemode testing procedures shall conform to 526-7 - Method A.1 – One-Jumper Reference
3. Singlemode strands shall be tested at 1310 and 1550 nm.
4. Tests shall be performed bi-directionally.
5. Measured results shall be plus/minus 1 dB of loss budget guidelines.
6. As a minimum, the fiber test reports must shall include
 - Fiber Cable Number
 - Test Date
 - Fiber Type
 - Fiber Length
 - Wavelength of Test
 - Attenuation (Loss) in dB
 - Technician's Name
- B. Contractor must correct improper terminations and splices or replace failing cables and retest at his/her own expense until all strands achieve a repeatable passing measurement.
- C. All fiber optic couplers and connectors shall be thoroughly cleaned, be free of chips and scratches and all end-caps installed after the test procedures have been completed.
- D. Submit two hard copies of all test reports to University within 90 days of final completion.
- E. Submit two copies of all test reports in Acrobat format (PDF) to University within 90 days of final completion.
- F. Incorporate viewing software on disk so that no additional software loading will be required to view the test reports.
- G. Independent system certification may be required at the Contractor's expense in the event of non-performance of specified testing procedures and submittals or contested material and/or installation practices.

PART 4 - KSU Design Requirements

- A. The requirements listed below are specific to Kent State University. Specifications listed in the following section shall take precedence in case of conflicting information listed elsewhere in document.
 1. Intra-building fiber optic backbone cabling to be minimum 48-strand singlemode.

END OF SECTION 271323

SECTION 271333 - COMMUNICATIONS COAXIAL BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Communications coaxial cable.
 - 2. CATV coaxial cable.
 - 3. Coaxial cable hardware.
 - 4. Grounding.
 - 5. Identification products.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. EMI: Electromagnetic interference.
- D. IDC: Insulation displacement connector.
- E. LAN: Local area network.
- F. RCDD: Registered Communications Distribution Designer.

1.4 COAXIAL BACKBONE CABLING DESCRIPTION

- A. Coaxial cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connections, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connections may be located in communications equipment rooms or at entrance facilities.

1.5 SUBMITTALS

- A. Product Data: For each type of product.
- B. Qualification Data: For RCDD, and installation supervisor.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Technician], who shall be present at all times when Work of this Section is performed at Project site.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each coaxial cable on the reel for continuity.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Communications Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685.
 - 2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
 - 3. Communications, Riser Rated: Type CMR complying with UL 1666.
- B. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. CATV Plenum Rated: Type CATVP installed in riser raceways or cable routing assemblies, complying with NFPA 262.
 - 2. CATV Riser Rated: Type CATVR complying with UL 1666; or CATVP complying with NFPA 262] [installed in riser raceways or cable routing assemblies].

2.3 CATV COAXIAL CABLE

- A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. CommScope, Inc.
 - 3. Superior Essex.
 - 4. West Penn.
- C. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution" Article. Types are as follows:
- D. 1/2" Coaxial Hardline Cable (Unjacketed - Inter-Building)

1. Construction Materials
 - a. Jacket Material: Unjacketed
 - b. Center Conductor Material: Copper-clad aluminum
 - c. Construction Type: Swaged
 - d. Dielectric Material: Foam PE
 - e. Outer Conductor Material: Aluminum
 2. Dimensions
 - a. Diameter Over Center Conductor, nominal: 2.769 mm | 0.109 in
 - b. Diameter Over Dielectric, nominal: 11.481 mm | 0.452 in
 - c. Diameter Over Outer Conductor, nominal: 12.700 mm | 0.500 in
 - d. Outer Conductor Thickness, nominal: 0.6096 mm | 0.0240 in
 3. Electrical Specifications
 - a. dc Resistance, Inner Conductor, nominal: 1.35 ohms/kft
 - b. dc Resistance, Outer Conductor, nominal: 0.37 ohms/kft
 - c. dc Resistance, Loop, nominal: 1.72 ohms/kft
 - d. dc Resistance Note: Nominal values based on a standard condition of 68 °F
 - e. Capacitance: 50.2 pF/m | 15.3 pF/ft
 - f. Capacitance Tolerance: ± 1.0 pF/ft
 - g. Characteristic Impedance: 75 ohm
 - h. Characteristic Impedance Tolerance: ± 2 ohm
 - i. Nominal Velocity of Propagation (NVP): 87 %
 - j. Operating Frequency Band: 1002–1218 MHz | 5–1002 MHz
 - k. Structural Return Loss: 30 dB @ 5–1002 MHz.
 4. General Specifications
 - a. Cable Type 500 series
 - b. Jacket: Unjacketed
 - c. Warranty: One year
 - d. Manufacturer/Model: Commscope P3® 500 CA
- E. 1/2" Coaxial Hardline Cable (Riser-rated Intra-Building)

1. Construction Materials
 - a. Jacket Material: Fire retardant PE
 - b. Center Conductor Material: Copper-clad aluminum
 - c. Construction Type: Swaged
 - d. Dielectric Material: Foam PE
 - e. Outer Conductor Material: Aluminum
2. Dimensions
 - a. Diameter Over Center Conductor, nominal: 2.769 mm | 0.109 in
 - b. Diameter Over Dielectric, nominal: 11.481 mm | 0.452 in
 - c. Diameter Over Outer Conductor, nominal: 12.700 mm | 0.500 in
 - d. Diameter Over Jacket, nominal: 14.224 mm | 0.560 in
 - e. Jacket Thickness, nominal: 0.7620 mm | 0.300 in
 - f. Outer Conductor Thickness, nominal: 0.6096 mm | 0.0240 in

3. Electrical Specifications
 - a. dc Resistance, Inner Conductor, nominal: 1.35 ohms/kft
 - b. dc Resistance, Outer Conductor, nominal: 0.37 ohms/kft
 - c. dc Resistance, Loop, nominal: 1.72 ohms/kft
 - d. dc Resistance Note: Nominal values based on a standard condition of 68 °F
 - e. Capacitance: 50.2 pF/m | 15.3 pF/ft
 - f. Capacitance Tolerance: ±1.0 pF/ft
 - g. Characteristic Impedance: 75 ohm
 - h. Characteristic Impedance Tolerance: ±2 ohm
 - i. Jacket Spark Test Voltage: 5000 Vac
 - j. Nominal Velocity of Propagation (NVP): 87 %
 - k. Operating Frequency Band: 1002–1218 MHz | 5–1002 MHz
 - l. Structural Return Loss: 30 dB @ 5–1002 MHz.
4. Environmental Specifications
 - a. Environmental Space: Riser
 - b. Flame Test Listing: CATVR | NEC Article 820
 - c. UL Temperature Rating: 60 °C | 140 °F
5. General Specifications
 - a. Cable Type 500 series
 - b. Jacket Color: Black
 - c. Warranty: One year
 - d. Manufacturer/Model: Commscope P3® 500 JCAR

F. 1/2" Coaxial Hardline Cable (Plenum-rated Intra-Building)

1. Construction Materials
 - a. Jacket Material: Fire retardant PVC
 - b. Center Conductor Material: Copper-clad aluminum
 - c. Construction Type: Swaged
 - d. Dielectric Material: FFEP
 - e. Outer Conductor Material: Aluminum
2. Dimensions
 - a. Diameter Over Center Conductor, nominal: 2.769 mm | 0.109 in
 - b. Diameter Over Dielectric, nominal: 11.481 mm | 0.452 in
 - c. Diameter Over Outer Conductor, nominal: 12.700 mm | 0.500 in
 - d. Diameter Over Jacket, nominal: 13.614 mm | 0.536 in
 - e. Jacket Thickness, nominal: 0.5080 mm | 0.200 in
 - f. Outer Conductor Thickness, nominal: 0.6096 mm | 0.0240 in
3. Electrical Specifications
 - a. dc Resistance, Inner Conductor, nominal: 1.42 ohms/kft
 - b. dc Resistance, Outer Conductor, nominal: 0.37 ohms/kft
 - c. dc Resistance, Loop, nominal: 1.79 ohms/kft
 - d. dc Resistance Note: Nominal values based on a standard condition of 68 °F
 - e. Capacitance: 52.5 pF/m | 16.0 pF/ft
 - f. Capacitance Tolerance: ±1.0 pF/ft
 - g. Characteristic Impedance: 75 ohm
 - h. Characteristic Impedance Tolerance: ±2 ohm

- i. Jacket Spark Test Voltage: 1000 Vac
 - j. Nominal Velocity of Propagation (NVP): 84 %
 - k. Operating Frequency Band: 1002–1218 MHz | 5–1002 MHz
 - l. Structural Return Loss: 30 dB @ 5–1002 MHz.
- 4. Environmental Specifications
 - a. Environmental Space: Indoor | Plenum
 - b. Flame Test Listing: CATVP | NEC Article 820
 - c. UL Temperature Rating: 75 °C | 167 °F
- 5. General Specifications
 - a. Cable Type 500 series
 - b. Jacket Color: White
 - c. Warranty: One year
 - d. Manufacturer/Model: Commscope 2312V WTRL 1/2" Plen Trunk
- G. RG-11 Type Quad-Shield Plenum Video Coaxial Cable (Intra-Building Backbone)
 - 1. Construction Materials
 - a. Construction Type Non-armored
 - b. Center Conductor Material Copper-clad steel wire
 - c. Dielectric Material Foam FEP
 - d. Inner Shield (Braid) Coverage 60 %
 - e. Inner Shield (Braid) Gauge 36 AWG
 - f. Inner Shield (Braid) Material Tinned copper
 - g. Inner Shield (Tape) Material Aluminum/Poly
 - h. Outer Shield (Braid) Coverage 50 %
 - i. Outer Shield (Braid) Gauge 36 AWG
 - j. Outer Shield (Braid) Material Tinned copper
 - k. Outer Shield (Tape) Material Aluminum/Poly, non-bonded
 - l. Jacket Material PVC
 - 2. Dimensions
 - a. Cable Length 305 m | 1000 ft
 - b. Cable Weight 69.00 lb/kft
 - c. Diameter Over Center Conductor 1.6281 mm per 1 strand 0.0641 in per 1 strand
 - d. Diameter Over Dielectric 7.0612 mm | 0.2780 in
 - e. Diameter Over Inner Shield (Tape) 7.214 mm | 0.284 in
 - f. Diameter Over Jacket Tolerance ± 0.008 in
 - g. Diameter Over Jacket, nominal 9.042 mm | 0.356 in Jacket Thickness 0.432 mm | 0.017 in Jacket Thickness, minimum spot 0.305 mm | 0.012 in
 - h. Diameter Over Inner Shield (Braid) 7.595 mm | 0.299 in
 - i. Diameter Over Outer Shield (Braid) 8.204 mm | 0.323 in
 - 3. Electrical Specifications
 - a. Capacitance 52.5 pF/m | 16.0 pF/ft
 - b. Characteristic Impedance 75 ohm
 - c. Characteristic Impedance Tolerance ± 3 ohm
 - d. Conductor dc Resistance 11.00 ohms/kft
 - e. Dielectric Strength, conductor to shield 4000 Vdc
 - f. Jacket Spark Test Voltage 2500 Vac
 - g. Nominal Velocity of Propagation (NVP) 86 %
 - h. Shield dc Resistance 1.70 ohms/kft

- i. Structural Return Loss 15 dB @ 1000–3000 MHz | 20 dB @ 5–1000 MHz
 - j. Structural Return Loss Test Method 100% Swept Tested Environmental Specifications
- 4. Environmental Space Plenum
 - a. Flame Test Method CMP
 - b. Safety Standard cETL | ETL
 - c. UL Temperature Rating 75 °C | 167 °F
- 5. General Specifications
 - a. Cable Type Series 11
 - b. Jacket Color White
 - c. Supported Application Video
 - d. Manufacturer/Model: Commscope 2287V

2.4 COAXIAL CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Corning Gilbert
 - 2. Ideal
 - 3. Leviton Manufacturing Co., Inc.
- C. Coaxial-Cable Connectors: Type F, 75 ohms.

2.5 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Comply with requirements specified in Section 271100 "Communications Equipment Room Fittings." Comply with requirements in Section 270528 "Pathways for Communications Systems" for installation of conduits and wireways.

B. Comply with Section 270528.29 "Hangers and Supports for Communications Systems."

C. Drawings indicate general arrangement of pathways and fittings.

D. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.4 INSTALLATION OF COAXIAL BACKBONE CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
3. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 8. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
 9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.
- C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend coaxial cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.
- E. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.
- F. Group connecting hardware for cables into separate logical fields.
- G. Separation from EMI Sources:
1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

- b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- 4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 - 5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-B and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 2 AWG grounding electrode conductor from grounding bus bar to main electrical service, local panel, and building steel.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: Class 3.
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas

and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Label each unit and field within distribution racks and frames.
3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

B. Tests and Inspections:

1. Visually inspect coaxial jacket materials for NRTL certification markings.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test coaxial backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271333

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Enhanced Category 5 (Cat 5E) UTP.
 - 2. Cat5E Connectivity Hardware.
 - 3. Augmented Category 6 (Cat 6A) UTP.
 - 4. Cat6A Connectivity Hardware
 - 5. Cabling identification products.

1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. LAN: Local area network.
- E. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- F. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- G. RCDD: Registered Communications Distribution Designer.
- H. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections patch panels and work area outlets, wireless access points, security cameras, etc.
 - 1. Horizontal cabling shall contain no transition points or consolidation points between the horizontal cross-connect and the telecommunications equipment outlet without prior permission from Owner.

2. Bridged taps and splices shall not be installed in the horizontal cabling.

- B. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.5 SUBMITTALS

- A. Product Data sheet: For each type of product.
- B. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- C. Product Data Sheet: For each type of product.

1.6 CLOSE OUT SUBMITTALS

- A. As Built Drawings: Reviewed by RCDD.
1. Updated Jack List. Every cable has its own line with connectivity code in Excel and PDF.
 2. As-Built Drawings
 - a. Floor plan with outlet locations, connectivity code and outlet number in PDF format.
- B. Test Reports for all installed cables.
1. Each test report must indicate full Class 3 cable label.
 2. Test reports must indicate pass or fail.
 3. All failed cables shall be replaced.
 4. Cables with marginal test results shall be replaced.
 5. Submit to Owner in PDF format.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685.

2.3 ENHANCED CATEGORY-FIVE (Cat 5E) UTP

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Berk-Tek Leviton; a Nexans/Leviton alliance.
 - 2. CommScope, Inc.
 - 3. General Cable; General Cable Corporation.
 - 4. Superior Essex.
- C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.
- D. Cable Rating: Plenum.
- E. Jacket:
 - 1. Yellow
- F. Basis of design Manufacturer/Model: Commscope 5E55

2.4 CAT5e CONNECTIVITY HARDWARE

- A. Description: Hardware designed to terminate UTP cabling.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden

C. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Cat 5E UTP.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Patch Panel: 2 Rack Unit Modular panels, black, 48 port, unloaded, for snap in installation of Modular jacks.

1. Features:
 - a. 48 unloaded (empty) ports
 - b. 2 Rack unit height
 - c. Black
 - d. Labeling areas adjacent to conductors.
2. Manufacturer/Model: Belden, AX103115 - KeyConnect Patch Panel Flat 48 Port, 2U, Empty

E. Modular Jacks:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap into faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Color: BLACK
5. Manufacturer/Model: RV5JKUBK-S1 (single pack) RV5MJKUBK-B4 (bulk pack of 24) - Belden REVConnect Cat5e Jack, Black;

F. Faceplates:

1. Vertical single and double gang faceplates designed to mount to single/double gang wall boxes.
2. Plastic Faceplate: High-impact plastic
3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
4. Color: Gray
5. Insert blank modules (color to match faceplate) in all unused ports.
6. Flush Mount faceplates Manufacture/Model:
 - a. Single gang: Belden AX106669 - MediaFlex Angled Edge Single-Gang Faceplate
 - b. Double gang: Belden AX106673 - MediaFlex Angled Edge Double-Gang Faceplate
 - c. Angled jack insert, 2 port: Belden AX104483 - MediaFlex Keyconnect Style insert 2-port, Angled
 - d. Blank faceplate insert 1 unit: Belden AX101757 - MediaFlex Filler Insert 1-unit
 - e. Blank faceplate insert, 2 unit: Belden AX101761- MediaFlex Filler Insert 2-units
 - f. Blank port insert: Belden AX107026 - Keyconnect Blank insert (qty 50)

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7. Wallphone

- a. Manufacture/Model: Leviton 4108W-0SP
- 8. Surface Mount Manufacture/Model
 - a. 1 port: Belden AX107030 - Keyconnect Side Entry Box 1-Port Gray
 - b. 2 port: Belden AX107031 - Keyconnect Side Entry Box 2-Port Gray
 - c. 4 port: Belden AX107032 - Keyconnect Side Entry Box 4-Port Gray
 - d. 6 port: Belden AX107033 - Keyconnect Side Entry Box 6-Port Gray
- 9. Coordinate faceplates within specialized enclosures, outlet boxes, and modular furniture systems with manufacture to ensure proper fit.

2.5 CATEGORY 6a TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
- B. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- C. Conductors: 100-ohm, 23 AWG solid copper.
- D. Shielding/Screening: Unshielded twisted pairs (UTP)
- E. Cable Rating: Plenum.
- F. Jacket: BLUE.
- G. Manufacture/Model:
 - 1. Commscope UN874035104/10 - CSP446 Cat 6A cable, blue, 1,000' REEL
 - 2. Commscope UN874035114/10 - CSP446 Cat 6A cable, blue, 1,000' COMM PAK
 - 3. Commscope UN874035184/30 - CSP446 Cat6 A cable, blue, 3,000' REEL

2.6 CAT6a CONNECTIVITY HARDWARE

- A. Description: Hardware designed to terminate UTP cabling.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden
- C. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Cat 6A UTP.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Patch Panel: 2 Rack Unit Modular panels, black, 48 port, unloaded, for snap in installation of Modular jacks.
 - 1. Features:
 - a. 48 unloaded (empty) ports

- b. 2 Rack unit height
 - c. Black
 - d. Labeling areas adjacent to conductors.
2. Manufacturer/Model: Belden, AX103115 - KeyConnect Patch Panel Flat 48 Port, 2U, Empty

E. Modular Jacks:

- 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
- 2. Designed to snap into faceplate.
- 3. Standard: Comply with TIA-568-C.2.
- 4. Color: BLUE
- 5. Manufacturer/Model:
 - a. Belden RVAMJKUBL-S - REVConnect Cat 6A Jack; Blue - Single Pack
 - b. Belden RVAMJKUBL-B24 - REVConnect Cat 6A Jack; Blue - Bulk Pack(24)

F. Faceplates:

- 1. Vertical single and double gang faceplates designed to mount to single/double gang wall boxes.
- 2. Plastic Faceplate: High-impact plastic.
- 3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
- 4. Color: Gray
- 5. Insert blank modules (color to match faceplate) in all unused ports.
- 6. Flush Mount faceplates Manufacture/Model:
 - a. Single gang: Belden AX106669 - MediaFlex Angled Edge Single-Gang Faceplate
 - b. Double gang: Belden AX106673 - MediaFlex Angled Edge Double-Gang Faceplate
 - c. Angled jack insert, 2 port: Belden AX104483 - MediaFlex Keyconnect Style insert 2-port, Angled
 - d. Blank faceplate insert 1 unit: Belden AX101757 - MediaFlex Filler Insert 1-unit
 - e. Blank faceplate insert, 2 unit: Belden AX101761- MediaFlex Filler Insert 2-units
 - f. Blank port insert: Belden AX107026 - Keyconnect Blank insert (qty 50)
- 7. Wallphone
 - a. Manufacture/Model: Leviton: 4108W-0SP
- 8. Surface Mount Manufacture/Model
 - a. 1 port: Belden AX107030 - Keyconnect Side Entry Box 1-Port Gray
 - b. 2 port: Belden AX107031 - Keyconnect Side Entry Box 2-Port Gray
 - c. 4 port: Belden AX107032 - Keyconnect Side Entry Box 4-Port Gray
 - d. 6 port: Belden AX107033 - Keyconnect Side Entry Box 6-Port Gray
- 9. Coordinate faceplates within specialized enclosures, outlet boxes, and modular furniture systems with manufacture to ensure proper fit.

2.7 LIGHTING PROTECTION

- A. Outdoor or buried drop cable must be protected at both ends.
 - 1. Drops serving Talk-a-Phones shall be Cat 3 buried drop rated cable and use Manufacturer/Model: Circa 502-A350.
 - 2. All other outdoor drops use buried drop rated Cat 6A cable should use lightning protection from Porta Systems series 505 lightning protection with 65 fuses with Manufacturer/Model: Porta Systems 505E4-65

2.8 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.9 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except in accessible ceiling spaces, and attics, where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."

- C. Comply with Section 270529 "Hangers and Supports for Communications Systems."
- D. Comply with Section 270536 "Cable Trays for Communications Systems."
- E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Terminate cabling per T-568B.
 - 2. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 3. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 4. All termination methods shall meet TIA-568 requirements and manufacturer recommendations.
 - 5. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 6. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 8. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual , Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 - 10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 12. In the communications equipment room, install a 10-foot-long service loop. At wall outlet above ceiling, install 6-foot service loop in ceiling space.
 - 13. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- C. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports with random spacing not more than 60 inches apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-B and NECA/BICSI-607.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: Class 3.
- B. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- C. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware.

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test cables after termination but before cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in most current revision of the TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

- b. Field tester must be calibrated to the type, manufacturer and catalog number of the cable to be tested.
 - c. Any measurements that fall within the tester's margin of error will be considered failed
 - d. All failed cables must be removed, replaced and retested at the contractor's expense until they achieve a repeatable passing measurement is taken.
- B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- C. Test to be performed per cable category (5E or 6A) as specified by BICSI section or manual.
- D. Prepare test and inspection reports in PDF format.
 - 1. Submit per Section Closeout Submittals.

PART 4 – KSU DESIGN REQUIREMENTS

4.0 KSU REQUIREMENTS

- 1. All conduit and other teledata pathways should be designed for Cat 6A cabling with no more than 28% fill. We allow for 50% growth in all new construction. This is 14% fill.
- 2. Blue Cat 6A is required for all horizontal cabling in new building construction and major building renovations projects. Small projects with horizontal cable being pulled to existing TeleData closets may possibly use yellow Cat 5E cabling. KSU Engineer to determine if Cat 5E is acceptable for use on project.
- 3. Wireless access points outlets: will require one (1) Cat 6A cable to each device.
- 4. Fire Alarms outlets; will always require two (2) Cat 6A cables to each device. Standard Cat 6A flush or surface faceplates are used - RJ31x style outlets are NOT to be used. Also one cable #18/2 STP plenum rated cable should be installed from fire alarm panel to local building automation head end panel (JCI).
- 5. Elevator outlets: are to be located in the elevator machine room next to the elevator controller enclosure. Standard Cat6 A flush or surface faceplates are used. The outlet is to be a dual port configuration. The left ("A") port is to be a standard single cat6A drop from the MDF. The right ("B") port is to be connected into the elevator controller phone terminals. The circuit is completed with a jumper between the left port and right port.
- 6. Security camera outlets require one Cat 6A cable and jack.
- 7.. Teledata outlets in areas where furniture partitions are located need to keep clear access to the outlets. Consider eliminating modesty panels in these areas.

8. All cabling (backbone fiber, backbone copper, Cat 5E, and Cat 6A) is to be tested with test reports provided in electronic format. Fiber is to be tested using an OTDR. Cat 5E is to be tested using the standard EIA/TIA Cat5E test. Cat6A is to be tested using the standard EIA/TIA Cat 6A test. Cat 3 copper is to be tested via BISCII standard using the wire map test for all pairs in backbone and other than horizontal cabling shall be performed and recorded for all segments. Wire map tests include:
 - a. Continuity to the remote end.
 - b. Shorts between any two or more conductors.
 - c. Crossed pairs
 - d. Reversed pairs
 - e. Split pairs
 - f. Any other miswiring
9. The length of each backbone cable segment should be measured and recorded with electronic test results provided to KSU in report summary form on company letterhead.
10. Designer shall include a jack list matching contract document design created in Excel.
11. Installation contractor to provide as-built drawings with jack list matching installation in Excel. Design engineer to provide installer with electronic copy of spreadsheet.

END OF SECTION 271513

SECTION 271533 - COMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. CATV coaxial cable.
 - 2. Coaxial cable hardware.
 - 3. Grounding.
 - 4. Identification products.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. LAN: Local area network.
- E. RCDD: Registered Communications Distribution Designer.

1.4 COAXIAL HORIZONTAL CABLING DESCRIPTION

- A. Coaxial horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1.5 SUBMITTALS

- A. Product Data Sheet: For each type of product.
 - 1. Nominal OD.
 - 2. Minimum bending radius.
 - 3. Maximum pulling tension.

- B. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each coaxial cable on the reel for continuity.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

- A. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. CATV Plenum Rated: Type CATVP complying with NFPA 262.

2.3 CATV COAXIAL CABLE

- A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. CommScope, Inc.
 - 3. Superior Essex.
- C. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution Systems" Article. Types are as follows:
- D. RG-6: UL Type CATVP.
 - a. No. 18 AWG, solid, copper-covered steel conductor.
 - b. Plenum rated CMP
 - c. Gas-injected, foam-PE insulation.
 - d. Quad shielded with 60 percent 34AWG aluminum braided inner shield, 40 percent 34AWG aluminum braided inner shield.
 - e. Suitable for indoor installations.
 - f. Manufacturer/Model: Commscope 2227V
 - g. Electrical Specifications
 - Capacitance 50.9 pF/m | 15.5 pF/ft
 - Characteristic Impedance 75 ohm
 - Characteristic Impedance Tolerance ± 3 ohm
 - Conductor dc Resistance 28.60 ohms/kft
 - Dielectric Strength, conductor to shield 2000 Vdc
 - Jacket Spark Test Voltage 2500 Vac
 - Nominal Velocity of Propagation (NVP) 84 %
 - Shield dc Resistance 5.30 ohms/kft
 - Structural Return Loss 15 dB @ 1000–3000 MHz | 20 dB @ 5–1000 MHz
 - Structural Return Loss Test Method 100% Swept Tested

2.4 COAXIAL CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Corning Gilbert
- C. Coaxial-Cable Connectors: Type F, 75 ohms.
- D. Jacks and Jack Assemblies: Modular, color-coded, with female Type F connectors.

E. Faceplates:

1. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.

2.5 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF COAXIAL HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
 3. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 8. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
 9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.
- C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend coaxial cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Coil cable 10 feet long not less than 12 inches in diameter below each feed point.
- E. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.
- F. Group connecting hardware for cables into separate logical fields.
- G. Separation from EMI Sources:
1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-B and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communication Systems."
 1. Administration Class: Class 3.
 2. Color-code fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- C. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communications cabling, use a different color for jacks and plugs of each service.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections.
- B. Tests and Inspections:
 1. Visually inspect coaxial jacket materials for NRTL certification markings.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Test coaxial horizontal copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.
 4. Install cable TV distribution system to provide a usable television signal at each outlet. The signal shall be +8dBmv +/- 3dBmv across 75 ohms, minimum. Verify power range with university before tuning system. Demonstrate the performance of the CATV distribution system by measuring the dBmv levels at each location with a broadband power meter. Replace taps and/or adjust amplifier gain to provide the best possible picture for all locations.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 271533