THE University of Vermont MEDICAL CENTER

South Burlington, VT 05403

Outpatient Surgery Center

PROJECT MANUAL

Volume 2 (Divisions 21 – 33)

100% Construction Documents

Project No. 2021073

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PREPARED BY:

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SECTION 000110

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SECTION 210400

GENERAL CONDITIONS FOR FIRE PROTECTION TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

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

B. This section applies to certain sections of Division 26, "Electrical," and this section applies to all sections of Division 21, "Fire Protection" of this project specification unless specified otherwise in the individual sections.

C. The Drawings of other trades (Architectural, Structural, Landscape, Civil, Mechanical, Plumbing, Electrical, Communications and Fire Alarm) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

1.2 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

1.3 INTENT

A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.

B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.

C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.

D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.4 DEFINITIONS

A. “Approved equal” also known as “alternative” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

B. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

C. “Finished” refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

D. “Furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.

E. No Exceptions Taken – reviewed and determined to be in general conformance with contract documents.

F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

G. “Install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.

H. "Lead Free" shall mean not more than .25% in the wetted surface area.

I. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

J. “Provide” shall mean furnish (or supply) and install as necessary.

K. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

L. Remove: The term “remove” means “to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”

M. Special Warranties: The term “Special Warranties” are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

N. Standard Product Warranties: The term “Standard Product Warranties” are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

O. “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Fire Protection Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.

P. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."

Q. “Wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.

D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.6 SURVEYS AND MEASUREMENTS

A. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

B. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

1.7 CODES AND STANDARDS

A. Reference Standard Compliance
1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

B. The Following Codes and Standards listed below apply to all Fire Protection work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
Building Code Including all Supplements

Fire Safety Code Including all Supplements

The International Building Code

The International Mechanical Code

The International Fire Protection Code

The International Energy Conservation Code

NFPA 13, Standard for Installation of Sprinkler Systems

NFPA 70, the National Electrical Code

NFPA 101, the Life Safety Code

ASHRAE 90.1 and International Energy Conservation Code

C. The following Standards shall be used where referenced by the following abbreviations:

AIA	American Institute of Architects
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers

ASTM	American Society of Testing and Materials
AWS	American Welding Society
CISPI	Cast Iron Soil Pipe Institute
EJMA	Expansion Joint Manufacturing Association
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
HIS	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	Insurance Services Office
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSC	National Safety Council
OSHA	Occupational Safety and Health Administration
UL	Underwriters' Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.8 PERMITS AND FEES

A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.9 EQUIPMENT SUBSTITUTIONS

A. Certain manufacturers of material, apparatus or appliances are indicated in the drawings and specifications for this project. These items have been used as the basis of design, and as a convenience in fixing the minimum standard of workmanship, finish and design that is required. If the Contractors uses an “approved equal” alternative to the basis of design, and if the features of that alternative have an impact on other components of the Project, the Contractor shall include the necessary adjustments in those components, whether for architectural, structural, mechanical, electrical, fire protection, or any other elements, plus any adjustments for difference in performance.

B. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.

C. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for Architect and Engineer review.

D. Where the Contractor proposes to use an item that is different from the basis of design in the Drawings and specifications, and that will require the redesign of the structure, partitions, foundations, piping, wiring or any other component of the mechanical, plumbing, electrical, or architectural layout, the Contractor shall provide the necessary redesign of those components.

E. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the basis of design scheduled equipment or materials as hereinafter specified or shown on the drawings, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution, equivalent or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

F. If an alternative or substitute item results in a difference in quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit, and equipment from that specified or indicated on the Drawings, the Contractor shall furnish and install any such additional equipment required by the system, at no additional cost to the Owner including any costs added to other trades due to the equivalent change from the basis of design detailed in the drawings or included within the specifications.

G. Equipment, material or devices submitted for review as an “equivalent” shall meet the following requirements:
   1. The equivalent shall have the same construction features such as, but not limited to:
      a. Material thickness, gauge, weight, density, etc.
      b. Welded, riveted, bolted, etc., construction
      c. Finish, undercoating, corrosion protection
   2. The equivalent shall perform with the same or better operating efficiency.
   3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.

4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.

H. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
   1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
   2. Submit three (3) copies of each request for substitution for consideration.
   3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
      a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
      b. Samples, where applicable or requested.
      c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
      d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
      e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
      f. Cost information, including a proposal of the net change, if any in the Contract Sum.
      g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
      h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
      i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.

1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.
2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.10 SUBMITTAL PROCEDURES

A. Provide Submittals in accordance with the requirements of Division 01 and as indicated in the following.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
2. If an intermediate submittal is necessary, process the same as the initial submittal.
3. Allow two weeks for reprocessing each submittal.
4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
1. Include the following information on the label for processing and recording action taken.
   a. Project name.
   b. Date.

c. Name and address of Engineer.
d. Name and address of Contractor.
e. Name and address of subcontractor.
f. Name and address of supplier.
g. Name of manufacturer.
h. Number, title and paragraph of appropriate Specification Section.
i. Drawing number and detail references, as appropriate.

E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.

G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

H. LEED Submittals: Provide manufacturers' or third-party certification of testing to and compliance with the California Department of Public Health (CDPH) Standard method v1.2-2017, that includes the following information:
1. The exposure scenario used to determine compliance.
2. The range of total VOCs after 14 days, measured as specified in the CDPH Standard Method v1.2:
3. 0.5 mg/m^3 or less;
4. Between 0.5 and 5.0 mg/m^3; or
5. 5.0 mg/m^3 or more
6. Laboratory accreditation under ISO/IEC 17025.
7. Claims of compliance for wet-applied products must state the amount applied in mass per surface area
8. Provide MSDS or other manufacturer documentation with disclosure of VOC content for all wet-applied products.
9. Complete "LEED Materials Documentation Sheet" with IEQc2 information for adhesives/sealants installed within the waterproofing membrane.

1.11 SHOP DRAWINGS

A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated sprinkler layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received

shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Fire Protection Contract. Refer to Division 01 for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.

C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, performance cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, electrical, etc.

E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.

G. "No Exception Taken" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.

H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.

I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.

J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.

K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

L. LEED Requirements:

1. For field applications that are inside the weatherproofing membrane: Adhesives/sealants must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario. The default scenario is the private office scenario.
2. All adhesives/sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.

1.12 COORDINATION DRAWINGS

A. Prepare coordination drawings drawn in the latest AutoCAD or Revit version in accordance with Division 01 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of fire protection equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
      a. Clearances for servicing and maintaining equipment and space for equipment disassembly required for periodic maintenance.
      b. Equipment connections and support details.
      c. Exterior wall and foundation penetrations.
      d. Fire-rated wall and floor penetrations.
      e. Sizes and locations of required concrete pads and bases.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

E. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.

F. Work shall not be performed until coordination drawings have been approved by the architect and engineer.

G. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. If the Contractor elects to obtain the Engineers electronic files an Electronic Drawing File Release Form must be submitted with payment. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic Drawing File Release Form, the Engineer will provide copies of the electronic files for the Contractor’s use. A copy of

the Electronic Drawing File Release Form is appended to the end of this specification section

1.13 COORDINATION WITH OTHER DIVISIONS

A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.

B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.

C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.

D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

1.14 WORKMANSHIP

A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

E. All labor for installation of Fire Protection systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat,

workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.15 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.

B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.16 TEMPORARY UTILITIES

A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. First Aid Supplies: Comply with governing regulations.

D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.

E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
   1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.

F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.

G. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or

polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

H. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.17 PROJECT PHASING

A. Work under each Section shall include all necessary temporary connections, equipment, piping, fire stopping, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain existing systems operational or to accommodate the construction phasing of the project.

1.18 PROTECTION OF MATERIALS AND EQUIPMENT

A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.

B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.19 ADJUSTING AND TESTING

A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.

B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing that the equipment was installed according to manufacturer's recommendations and is operating as intended by the manufacturer.

1.20 CLEANING

A. The Contractor shall thoroughly clean and flush all piping and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.

B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

C. During the course of construction, all pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.

D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
   1. Remove labels that are not permanent labels.
   2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
   3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
   4. Wipe surfaces of fire protection equipment. Remove excess lubrication and other substances.

F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.

G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.21 OPERATING AND MAINTENANCE

A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner’s representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

D. An authorized manufacturer’s representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; controls, water heaters, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.

E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

1.22 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with the requirements of Division 01 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.

B. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing and operating instructions including lubrication charts and schedules.
5. Emergency and safety instructions.
6. Spare parts list.
7. Copies of warranties.

8. Wiring diagrams.
9. Recommended "turn around" cycles.
10. Inspection procedures.
11. Approved Shop Drawings and Product Data.
12. Equipment Start-up Reports.

C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, bearing number, etc. Schedule shall include maintenance to be done and frequency.

D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.23 ACCEPTANCES

A. The equipment, materials, workmanship, design and arrangement of all work installed under the Fire Protection Sections shall be subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, the Fire Protection Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Fire Protection Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.

C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner’s representative.

D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Fire Protection Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.

F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.24 RECORD DRAWINGS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
1. Dimensional change
2. Revision to drawing detail
3. Location and depth of underground utility
4. Revision to pipe routing
5. Revision to electrical circuitry
6. Actual equipment location
7. Pipe size and routing
8. Location of concealed internal utility
9. Changes made by Change Order
10. Details not on original Contract Drawing
11. Information on concealed elements which would be difficult to identify or measure later

C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.

D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.

E. Note related Change Order numbers where applicable.

F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

G. Final record documents shall be prepared in the latest AutoCAD or Revit version and CD Rom of all drawings. All field changes shall be drafted by the Contractor. In addition, a set of pdf files and a clean set of reproducible paper copies shall be turned over to the Owner at the completion of the work.

1.25 WARRANTIES AND BONDS

A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
1. General close-out requirements included in Division 01.
2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions-02 through -50.

3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.26 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit

properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
   1. Refer to individual Sections of Divisions-02 through -50 for specific content requirements, and particular requirements for submittal of special warranties.

J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
   1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
   2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
   3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.27 GUARANTEES

A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

1.28 PROJECT CLOSE-OUT

A. Contractor shall submit annual maintenance proposal to the Architect/Engineer for review and approval as part of the close out documents.

B. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents in accordance with Division 01.

C. Deliver tools, spare parts, extra stock, and similar items.

D. Complete start-up testing of systems, including measuring and documenting all required startup checklist requirements documented in installation and maintenance instructions by the equipment manufacturer, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

E. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

F. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
   1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
   2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION

Electronic Drawing File Release Form

DELIVERY OF ELECTRONIC FILES FOR: _____

Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Contractor covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Contractor further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Contractor agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Contractor agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Contractor be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ _____

Contractor's Signature Date

_____

Company - Title

_____ _____

Architects' Signature Date

_____

Firm - Title

_____ _____

Owner's Signature Date

_____

Company - Title

SECTION 210500

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes pipe, fittings, valves, backflow preventers and connections for sprinkler systems.

B. Related Sections:
1. Division 01- General Requirements
2. Division 03 - Concrete.
3. Division 09 - Finishes.
4. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Piping.
5. Section 21 05 48 – Vibration and Seismic Controls for Fire-Suppression Piping and Equipment.
6. Section 21 13 13 – Wet-Pipe Sprinkler System.
7. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
2. ASME B16.3 – Malleable Iron Threaded Fittings, Class 150 and 300.
3. ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
4. ASME B16.5 - Pipe Flanges and Flanged Fittings
5. ASME B16.9 – Factory-made Wrought Steel Butt Welding Fittings.
6. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
7. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
8. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
9. ASME B16.25 – Butt Welding Ends.
10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
11. ASME Sec 9 - Welding and Brazing Qualifications.

B. American Society of Sanitary Engineers:
1. ASSE 1013 – Standard for Reduced Pressure Principal Backflow Preventer
2. ASSE 1015 – Standard for Double Check Backflow Preventer Assembly
3. ASSE 1047 – Standard for Reduced Pressure Detector Backflow Preventer
4. ASSE 1048 – Standard for Double Check Detector Assembly Backflow Preventer.

C. ASTM International:
1. ASTM A47 – Malleable Iron Castings.
2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
4. ASTM A126 – Standard for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
5. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

6. ASTM A536 – Standard for Ductile Iron Casting.
7. ASTM A795 - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
8. ASTM B32 - Standard Specification for Solder Metal.
9. ASTM B75 - Standard Specification for Seamless Copper Tube.
10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
11. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.

D. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.
3. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

E. American Water Works Association:
1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
4. AWWA C510 – Standard for Double Check Valve Backflow Prevention Assembly.
5. AWWA C511 – Standard for Reduced Pressure Principal Backflow Prevention Assembly.
6. AWWA C606 – Standard for Grooved and Shouldered Joints.

F. National Fire Protection Association:
1. NFPA 13 - Installation of Sprinkler Systems.
2. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.

G. Underwriter Laboratories, Inc.:
1. UL 1887 - Fire Tests of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.
2. UL - Fire Resistance Directory.

H. Factory Mutual:
1. FM - Factory Mutual Approval Guide.

1.3 SUBMITTALS

A. Division 01 - General Requirements.

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

C. Product Data: Submit manufacturer’s catalogue information. Provide data on valves, and fittings, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

D. Grooved joint couplings and fittings shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable manufacturer's model, style or series designation.

E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 - General Requirements.

B. Project Record Documents: Record actual locations of components and tag numbering.

C. Operation and Maintenance Data: Submit spare parts lists.

1.5 QUALITY ASSURANCE

A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).

B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State, State Fire Marshall, local ordinances, Underwriter's Requirements and OSHA. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.

C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
   1. NFPA Standards 13 and 14.
   2. State Building and Fire Codes.
   3. Local Jurisdictional Authorities.

D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

E. Valves: Bear UL and/or FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

F. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Division 01 - General Requirements.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - General Requirements.

B. Deliver and store valves in shipping containers, with labeling in place.

C. Furnish cast iron and steel valves with temporary protective coating.

D. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. All equipment, valves, gages and etc., shall be covered and protected during the execution of the work. All equipment and piping shall be protected from freezing. Labeling to remain in place.

F. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.

G. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.

1.9 WARRANTY

A. Division 01 - General Requirements.

1.10 EXTRA MATERIALS

A. Division 01 - General Requirements.

B. Furnish two sets of valve stem packing for each size and type of valve installed.

PART 2 PRODUCTS

2.1 BURIED PIPING

A. Ductile Iron Pipe: ANSI/AWWA C151, cement lined.
   1. Fittings: ANSI/AWWA C110, standard thickness.
   2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings.
   3. Joints: ANSI/AWWA C111, rubber gasket.

2.2 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A53; Schedule 40 welded or seamless carbon steel or Schedule 10 pipe shall be allowed for pipe sizes larger than 2" diameter when roll grooved mechanical couplings are used.
   1. Cast Iron Fittings: ANSI/ASME B16.1, flanges and flanged fittings; ANSI/ASME B16.4, screwed fittings.
   2. Malleable Iron Fittings: ANSI/ASME B16.3, screwed Class 300 type. Threads shall conform to ANSI/ASTM A47.
   3. Grooved Mechanical Fittings: ANSI A21.10/AWWA C-110 ductile iron; ASTM A536 Grade 65-45-12 ductile iron; ASTM A234 Grade WPB; or factory fabricated from carbon steel pipe conforming to ASTM A53; with grooves or shoulders designed to accept grooved end couplings. Fittings shall be of the same manufacturer as the adjoining couplings. Grooved Mechanical Couplings: ASTM A536 Grade 65-45-12, ductile iron housing, elastomer gasket with nuts and bolts to secure roll grooved pipe and fittings; based on Victaulic:

Fire Protection Service	Temperature Range	Gasket Recommendation
Freezer Applications	-40°F to 0°F	FlushSeal®, Grade L, Silicone
Water/Wet Systems	Ambient	C-Shape or EZ Style 009

      a. Manufacturers: Victaulic Models listed or approved equal by Tyco-Grinnell or Viking.
      b. Rigid Type Couplings: Housings cast with offsetting, angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA-13.
         1) 2 1/2" through 4": Factory assembled for direct stab installation without field disassembly. Victaulic Style 009 EZ.
         2) 5" through 8": Victaulic FireLock™ Style 005.
      c. Flexible Type Couplings: Use in locations where vibration attenuation and stress relief are required, and for seismic considerations in accordance with the manufacturer's instructions. Victaulic Style 75.

B. Cast Iron Pipe: AWWA C151.
   1. Fittings: AWWA C110, standard thickness.
   2. Joints: AWWA C111, rubber gasket.
   3. Mechanical Grooved Couplings: Ductile iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

C. Flexible Pipe Connections to Ceiling Mounted Sprinklers: Where sprinklers are installed in ceilings, contractor has the option to "hard pipe" or provide and install FLEXHEAD Series 2000 flexible piping, or approved equal as manufactured by Victaulic or Viking. Flexible pipe connections shall include a fully welded (non-mechanical fittings), braided, leak-tested, stainless steel sprinkler drop with a minimum internal corrugated hose diameter of 1 inch; one-piece multi-port ceiling bracket with removable attachment hub and self-securing integrated snap-on clip-ends, for attachment to ceiling grid without the need for a screw fastener. All flexible piping systems shall be UL Listed and FM Approved and rated for 175 psig.

2.3 VALVES

A. Manufacturers:
   1. Kennedy Valve Mfg. Co.
   2. Victaulic.
   3. Stockham.

4. Nibco.
5. Watts.
6. Hammond.
7. Milwaukee.

B. Gate Valves:
1. Up to and including 2 inches: Bronze body and trim, 175 lb, cold water non-shock working pressure, rising stem, hand wheel, solid wedge or disc, threaded ends.
2. Over 2 inches: Iron body, bronze trim, 175 lb, cold water non-shock working pressure, rising stem pre-grooved for mounting tamper switch, hand wheel, outside screw and yoke, solid taper bronze or cast iron wedge, grooved or flanged ends.
3. Over 4 inches: Iron body, bronze trim, 175 pound cold water, non-shock working pressure. Valve shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet with body and bonnet conforming to ASTM A126 Class B; replaceable bronze wedge facing rings; grooved or flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet and bronze bonnet bushing. Valve shall be capable of being repacked under pressure, with valve wide open.

C. Globe Valves:
1. Up to and including 2 inches: Class 125, Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity, packable under pressure.
2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

D. Angle Valves:
1. Up to and including 2 inches: Class 125, Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity, packable under pressure.
2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

E. Ball Valves:
1. Up to and including 2 inches: Bronze two piece body, standard port, chrome plated brass ball, 316 stainless steel stem, teflon seats brass stem nut, die-cast brass gear box with supervisory switches, threaded or grooved ends.
2. Over 2 inches: Manufacturers: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle.

F. Butterfly Valves:
1. Ductile iron body, ductile iron disc with EPDM disc coating and integrally cast stem, grooved ends.
2. Cast bronze body, ductile iron disc with EPDM disc coating and integrally cast stem, copper-tubing dimensioned grooved ends.
3. Cast iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck with 316 stainless steel stem, MSS-SP-67, 200 psi.
4. Disc: EPDM coated ductile iron or Aluminum bronze.
5. Operator: Notched plate lever handle, Handwheel and Weatherproof Actuator with supervisory switches.

G. Check Valves:
1. Up to and including 2 inches: Class 125, Bronze swing disc, screwed ends.
2. Horizontal Swing Over 2 inches:

a. 300 psi CWP, ductile iron body and coupled cap conforming to ASTM A536, Grade 65-45-12; horizontal swing, with stainless steel disc, elastomer seat, and grooved ends.
b. Class 175, cast iron body and bolted cap conforming to ASTM A126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends.
c. Valve shall be capable of being refitted while the valve remains in line.

3. Spring Actuated Over 2 inches:
a. 300 psi CWP, ductile iron body conforming to ASTM A536, Grade 65-45-12; vertical or horizontal check; with stainless steel spring and shaft.
1) 2-1/2 (65 mm) and 3 inches (75 mm): Aluminum bronze disc with disc mounted elastomer seal and PPS (Polyphenylene Sulfide) coated seat.
2) 4 inches (100 mm) and Larger: Elastomer coated ductile iron disc with welded-in nickel seat.

H. Drain Valves:
1. Compression Stop: Bronze with hose thread nipple and cap.
2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.

I. All valves shall be either UL listed or FM approved for use on fire protection systems

2.4 DOUBLE CHECK DETECTOR ASSEMBLIES

A. Manufacturers:
1. Watts
2. Zurn
3. Febco
4. Ames
5. NIBCO

B. 2-1/2 inches and Larger: ASSE 1048, 175 psig max working pressure, lead free, stainless steel body and internal parts, stainless steel removable cover to access both check valves, flanged ends, two independently operating spring loaded check valves. Provide with test cocks and two (2) cast iron OS&Y gate valves. Bypass assembly shall include bronze meter (readout per local water company's requirements), double check valves, (2) two shut-off valves and test cocks. Watts Model 3000SS.

2.5 UNIONS AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches (50 mm) and Under:
1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.

B. Dielectric Connections: Union, waterway fitting, or flange with water impervious isolation barrier.

2.6 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.

B. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.

C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

D. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.

E. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.

F. Vertical Support: Steel riser clamp or Angle ring.

G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.7 PIPE SLEEVES

A. Interior Partitions – Masonry Walls:
1. Cast-Iron Pipe Sleeve: Cast iron or ductile iron equivalent to ductile-iron pressure pipe, with plain ends.
2. Galvanized Steel Pipe Sleeve: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

B. Interior Partitions – Other Wall Types and Floor Penetrations Above Grade:
1. Cast-Iron Pipe Sleeve: Cast or fabricated of cast or ductile iron and
2. Galvanized-Steel Sheet Sleeve: 0.0239-inch thickness; round tube closed with longitudinal joint.

C. Exterior Walls and Slabs-on-Grade:
1. Manufacturers:
   a. Thunderline Link-Seal, Inc.
   b. Fernco
   c. BWM
2. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal.
3. Mechanical sleeve seals shall be installed at all grade to floor pipe penetrations, grade to wall pipe penetrations and exterior of building wall pipe penetrations.

D. Foundation Wall Sleeves: Where buried piping penetrates foundation walls completely below grade on all sides, provide Schedule 80 PVC sleeve; minimum 2” larger than OD of piping.

E. Pipe penetrations through fire rated assemblies: UL listed for assembly that is being penetrated.

F. All Other Wall and Floor Penetrations Above Grade:
1. Cast-Iron Pipe Sleeve: Cast or fabricated of cast or ductile iron.
2. Galvanized-Steel Sheet Sleeve: 0.0239-inch thickness; round tube.

G. Escutcheons: The Contractor shall provide chrome plated escutcheons on pipes and conduit wherever they pass through floors, ceilings, walls or partitions in finished locations.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate work of this Section with other affected work.

B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

C. Remove scale and foreign material, from inside and outside, before assembly.

D. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION – GENERAL

A. Install in accordance with manufacturer's instructions.

B. The Contractor shall maintain a clean and orderly site during the installation of the sprinkler system. Materials shall not be stored in the halls or other public areas.

C. Cutting, welding and other hot work shall not be permitted without permission from the building owner. Contractor shall provide a fire watch for one hour after all welding.

D. The required tests shall be witnessed by the Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect/Engineer.

E. Pipe Hangers and Supports:
1. Install in accordance with NFPA 13.
2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
3. Place hangers within 12 inches of each horizontal elbow.
4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports shall be provided with prime coat ready for Finish Painting. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.3 INSTALLATION – PIPE AND FITTINGS

A. All wet sprinkler piping must be plumbed on the heated side of the building insulation to prevent freezing. The fire protection contractor must install the wet sprinkler piping such that space is provided around all wet piping for insulation to be installed. The space required for insulation is dictated by the insulation R-value for the specific area as specified by the Architect.

B. Install piping in accordance with NFPA 13 for sprinkler systems.

C. Pipe and fitting shall be installed per the manufacture's installation requirements. The fire protection contractor shall furnish all materials necessary to meet these requirements including but not limited to hangers, support, insulation, shields, sleeves and power supplies.

D. Place piping in concealed spaces above finished ceilings unless noted otherwise.

E. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

F. Install piping to conserve building space, to not interfere with use of space and other work.

G. Pipe and fitting shall be installed per the manufacture's installation requirements. The fire protection contractor shall furnish all materials necessary to meet these requirements including but not limited to hangers, support, insulation, shields, sleeves and power supplies.

H. Group piping whenever practical at common elevations.

I. Install pipe sleeve at piping penetrations through partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.

J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

K. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

L. Pitch piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

M. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 90 00.

N. Do not penetrate building structural members unless indicated.

O. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.

P. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

Q. Provide dielectric fittings whenever joining two dissimilar metals.

R. Provide surge restrainers on all end of branches and arm overs in excess of 12-inches.

3.4 INSTALLATION – VALVES

A. Install drain valves at main shut-off valves, low points of piping and apparatus.

B. All valves shall be accessible for operation and servicing. Provide access panels where required.

C. Install valves with stems upright or horizontal, not inverted. Remove protective coatings after installation.

D. Install butterfly valves for shut-off or isolating service.

3.5 INSTALLATION – PIPE SLEEVES

A. Set sleeves in position in forms. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors minimum 1 inch above finished floor level. Caulk sleeves.

D. Where piping penetrates floor, ceiling, or wall, close off space around pipe with insulation and / or caulk airtight.

E. Mechanical Sleeve Seal: When piping or conduit penetrate a wall below grade, the floor of a mechanical room located above an occupied space, or other locations where water may cause damage, such penetrations shall be made completely watertight with mechanical sleeve seal, such that a liquid leak shall not pass through the penetration.

3.6 TESTING

A. Piping: The complete system shall be subject to a pressure test, and to such other tests as the authorities having jurisdiction may require. The pressure test shall be a hydrostatic pressure of 200 pounds per square inch for a period of two hours. The above ground piping and attached appurtenances shall show no pressure loss or leaks, refer to NFPA Standard 13 Hydrostatic tests. Before applying specified test pressure, all air must be expelled from the system. All defects of whatever type shall be repaired or replaced to the satisfaction of the Owner and authorities having jurisdiction and at no additional cost to the Owner. Packing rings, special joint bolts, gaskets, and other material required for the proper installation of the pipe and fittings shall be provided. Testing shall be completed prior to permanent sealing of walls and partitions.

B. Leaks in mechanical joints shall be repaired by dismantling the joint, reassembling it, and tightening the bolts in the correct order. Leaks in screw or grooved joint shall be repaired by dismantling the joint and reassembling it. Attempting to repair leaks in joints by over tightening the bolts or fittings shall not be permitted.

C. Upon satisfactory completion of all tests, the Contractor shall submit three copies of the Standard Contractors Material and Test Certificate to the Owner.

3.7 INTERFACE WITH OTHER PRODUCTS

A. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.8 CLEANING

A. Division 01 - General Requirements.

B. Clean entire system after other construction is complete.

END OF SECTION

SECTION 210516

EXPANSION FITTINGS AND LOOPS FOR FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Expansion joints.
2. Pipe alignment guides.
3. Swivel joints.
4. Pipe anchors.

B. Related Sections:
1. 21 05 00 - Common Work Results for Fire Suppression: Product and installation requirements for piping used in fire protection systems.
2. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
3. Section 21 13 13 – Wet-Pipe Sprinkler System.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.9 - Building Services Piping.
2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

1.3 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

1.4 SUBMITTALS

A. Division 01 - General Requirements.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer.

C. Product Data:
1. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Design Data: Indicate criteria and show calculations. Submit calculations sealed by a registered professional engineer.

E. Manufacturer's Installation Instructions: Submit special procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.

H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.5 CLOSEOUT SUBMITTALS

A. Division 01 - General Requirements.

B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

C. Operation and Maintenance Data: Submit adjustment instructions.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with the State Building Code and State Fire Safety Code.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of the Project.

1.8 PRE-INSTALLATION MEETINGS

A. Division 01 - General Requirements.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - General Requirements.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

A. Division 01 - General Requirements.

1.11 EXTRA MATERIALS

A. Division 01 - General Requirements.

B. Supply two 12 ounce containers of packing lubricant and cartridge style grease gun.

PART 2 PRODUCTS

2.1 EXPANSION JOINTS

A. Manufacturers:
1. Novia.
2. Metraflex.
3. Mason.
4. Vibration Elimination.

B. Carbon Steel Expansion Compensator:
1. Mason Mercer ECFFL / ECMN or approved equal.
2. Externally pressurized expansion compensator with 2 ply 304 stainless steel bellows in carbon steel casing,
3. Maximum Temperature: 300 degrees F at 170 psig.
4. Joint: Flanged or threaded carbon steel.

2.2 FLEXIBLE EXPANSION LOOP

A. All sprinkler pipe passing through or crossing building seismic joints, shall contain a flexible expansion loop, designed for seismic movement.

B. Flexible loops shall impart no thrust loads to building structure.

C. Loops shall be located at, or near, the building seismic joint. Seismic bracing shall not pass through building seismic joint and shall not connect or tie together different sides or parts of building structure. Refer to architectural drawings for locations of building seismic joints.

D. Flexible loops shall be capable of movement in the X, Y, and Z planes.

E. All flexible loop connections to sprinkler piping shall be installed, inspected, and tested in accordance with current NFPA-13 standards.

F. Flexible loops shall consist of two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return. Loops shall include a factory supplied, center support nut located at the bottom of the 180 degree return, and a drain/air release plug. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings.

G. Alternatively, the flexible loop shall consist of two flexible sections of hose and braid, two 45 degree elbows, and 90 degree return. Loops shall include a factory supplied, center

support nut located at the bottom of the 90 degree return, and a drain/air release plug. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings

H. Provide seismic breakaway hangers where recommended by the flexible expansion loop manufacturer. Seismic breakaway hanger shall be by the same manufacturer as the flexible expansion loop.

2.3 ACCESSORIES

A. Manufacturers:
1. Metraflex.
2. Mason.
3. Vibration Elimination.

B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

C. Swivel Joints: Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) O-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install Work in accordance with ASME B31.9.

B. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.

C. Provide support and anchors for controlling expansion and contraction of piping and at locations where piping crosses building expansion joints.. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

D. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.

E. Provide expansion loops as required.

3.2 MANUFACTURER'S FIELD SERVICES

A. Division 01 - General Requirements.

B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

SECTION 210548

VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Seismic restraints for fire protection piping and equipment.
2. Certification of seismic restraint designs and installation supervision.
3. Vibration control of fire protection piping and equipment.

B. Related Sections:
1. Section 21 05 00 – Common work results for Fire-Suppression.
2. Section 21 04 00 – General Conditions for Fire-Suppression Trades.
3. Section 21 05 16 - Expansion Fittings and Loops for Fire-Suppression Piping: Product requirements for anchors and piping expansion compensation.
4. Section 21 13 13 – Wet-Pipe Sprinkler System.

1.2 REFERENCES

A. National Fire Protection Association
1. NFPA 13 – Standard for the Installation of Sprinkler Systems
2. NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection

1.3 PERFORMANCE REQUIREMENTS

A. Provide seismic restraints in accordance with the requirements of NFPA 13 even if restraints are exempt by current state building codes.

1.4 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings:
1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
2. Provide all details of suspension and support for ceiling suspended equipment.
3. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
4. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

C. Product Data:
1. Catalog cuts or data sheets on specific restraints detailing compliance with the specification.
2. Detailed schedules of flexible and rigidly mounted equipment, showing seismic restraints by referencing numbered descriptive drawings.

D. Seismic Certification and Analysis:
1. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the State of Vermont.
2. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45° to the weakest mode.
3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length.

E. Manufacturer's Responsibilities:
1. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
2. Provide written certification that isolators meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of seismic restraints.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design application of seismic restraints under direct supervision of Professional Engineer experienced in design of this Work and licensed in the State where the Project is located.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. All seismic restraints described in this section shall be the product of a single manufacturer

B. Provide products manufactured by one of the following:
   1. Mason Industries
   2. Vibration Eliminator
   3. Vibro-Acoustics Ltd.
   4. Novia

2.2 SEISMIC CABLE RESTRAINTS

A. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.

B. Cables must be prestretched to achieve a minimum modulus of elasticity.

C. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.

D. Cables must not be allowed to bend across sharp edges.

E. Cable assemblies shall have an Anchorage Preapproval “OPA” Number from OSHPD in the State of California verifying the maximum load ratings.

F. Cable assemblies shall be type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.

2.3 SEISMIC SOLID BRACES

A. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint.

B. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment.

C. Seismic solid brace assembly shall have anchorage preapproval “OPA” number from OSHPD in the state of California verifying the maximum load ratings.

D. Solid seismic brace assemblies shall be type SSB, SSBS or SSRF as manufactured by Mason Industries, Inc.

2.4 SEISMIC ROD CLAMPS

A. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable.

B. Rod clamp assemblies shall have an Anchorage Preapproval “OPA” Number from OSHPD in the State of California.

C. Rod clamp assemblies shall be type SRC or UC as manufactured by Mason Industries, Inc.

2.5 CLEVIS CROSS BRACE

A. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt.

B. Clevis cross braces shall have an Anchorage Preapproval “OPA” Number from OSHPD in the State of California.

C. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.

2.6 STUD WEDGE ANCHORS

A. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is “rolled up” to create the thread.

B. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load.

C. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads.

D. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.

2.7 FEMALE WEDGE ANCHORS

A. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed.

B. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load.

C. Female wedge anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying to its allowable loads.

D. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.

PART 3 EXECUTION

3.1 INSTALLATION

A. All seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all submittal data.

B. Installation of seismic restraints must not cause any change of position of equipment or piping resulting in stresses or misalignment.

C. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor’s expense.

D. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.

E. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
   1. Flanges of structural beams.
   2. Upper truss cords in bar joist construction.
   3. Cast in place inserts or wedge type drill-in concrete anchors.

F. Seismic cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

G. Seismic cable assemblies are installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems only.

H. At locations where seismic cable restraints or seismic solid braces are located, the support rods must be braced when necessary to accept compressive loads.

I. At all locations where seismic cable restraints or seismic solid braces are attached to pipe clevis's, the clevis cross bolt must be reinforced with a preformed heavy gauge channel cross brace.

J. Drill-in concrete anchors for ceiling and wall installation shall be stud wedge anchors or female wedge anchors for floor mounted equipment.

K. All fire protection piping shall be braced in accordance with NFPA 13.

END OF SECTION

SECTION 211313

WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
1. Wet-pipe sprinkler system
2. Manual, wet standpipe system
3. Design, installation, and certification.

B. Related Sections:
1. Section 21 05 00 - Common Work Results for Fire Suppression: Product and execution requirements for pipe, fittings, valves, hangers, supports, identification and painting for placement by this section.
2. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Equipment.
3. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
4. Section 22 04 00 – General Conditions for Fire Suppression Trades
5. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.2 REFERENCES

A. National Fire Protection Association:
1. NFPA 13 - Installation of Sprinkler Systems.
2. NFPA 14 - Installation of Standpipe and Hose Systems.

B. Factory Mutual:
1. FM - Factory Mutual Approval Guide.

C. Underwritters Laboratory:
1. UL - Fire Resistance Directory.

1.3 SYSTEM DESCRIPTION

A. Provide a wet pipe system hydraulically designed in accordance with NFPA 13 and all requirements of the local Authority Having Jurisdiction.

B. Provide hose connections designed in accordance with NFPA 14 for manual, wet system standpipe; and all requirements of the local Authority Having Jurisdiction.

C. System to provide coverage for entire building.

D. Provide system to NFPA Standard occupancy requirements as noted on the drawings.

E. Interface system with building fire alarm system.

F. The sprinkler locations and piping arrangements indicated on the contract documents are diagrammatic. It is the responsibility of the contractor to fully coordinate sprinkler and piping locations with all other trades.

G. Sprinkler locations indicated on the Contract Documents indicate sprinkler coverage utilizing standard coverage sprinklers maximum 225 square feet per sprinkler for light hazard and 130 square feet per sprinkler for ordinary hazard. Extended coverage sprinklers shall not be installed in any locations unless specifically indicated on the Contract Document drawings.

H. All sprinklers installed in a light hazard classification occupancy shall be a listed quick response type unless noted otherwise.

I. Provide fire department connections and forward flow connections.

1.4 SUBMITTALS

A. Division 01 - General Requirements.

B. Where the terms “authorities having jurisdiction” is used, within this Specification, it is intended to include the Insurance Underwriter and all regulatory agencies having vested interest in this project.

C. Shop Drawings:
1. Provide fire protections shop drawings drawn to a minimum scale of ¼”=1’-0”. Indicate pipe materials used, joining methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
2. Provide hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls.
3. All sprinkler drawings and calculations shall bear the seal of a Professional Engineer licensed in the State where the Project is located. Seal and signature shall not be copied and shall be provided as an original drawing and each calculation.
4. Sprinklers shall be as shown on drawings and submittals and shall be specifically identified with the applicable style or series designation as published in the appropriate agency listing or approval. Trade names or other abbreviated designations are not permitted.

D. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

E. After successful review by the Engineer, submit sprinkler layout shop drawings, product data, and hydraulic calculations to authority having jurisdiction, Fire Marshall, and Owner's insurance underwriter for approval. Submit proof of approval to Architect/Engineer.

F. Grooved joint couplings and fittings shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series designation.

G. Manufacturer’s Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements.

1.5 CLOSEOUT SUBMITTALS

A. Division 01 - General Requirements.

B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.6 QUALITY ASSURANCE

A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).

B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State of Connecticut, State Fire Marshall, local ordinances and OSHA. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.

C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
1. NFPA Standard 13.
2. NFPA Standard 14.
3. NFPA Standard 24.
4. State Building and Fire Codes.
5. Local Jurisdictional Authorities.

D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

E. Valves: Bear UL and/or FM label or marking. Provide manufacturer’s name and pressure rating marked on valve body.

F. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.

G. Maintain one copy of each applicable NFPA standard on site.

H. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

I. Installer: Company specializing in performing work of this Section with minimum five years experience.

J. Design sprinkler system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State where the project is located.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Division 01 - General Requirements.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - General Requirements.

B. Deliver and store products in shipping containers, with labeling in place.

C. All equipment, valves, gages and etc., shall be covered and protected during the execution of the work. All equipment and piping shall be protected from freezing. Labeling to remain in place.

D. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.

E. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.

1.10 WARRANTY

A. Division 01 - General Requirements.

1.11 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish extra sprinklers under provisions of NFPA 13.

C. Provide signs and labeling per NFPA 13 and NFPA 14.

D. Furnish suitable wrenches for each sprinkler type.

E. Provide metal storage cabinet adjacent to the sprinkler riser.

PART 2 PRODUCTS

2.1 SPRINKLERS

A. Manufacturers:
1. Viking.
2. Tyco.
3. Victaulic.
4. Grinnell Corp.
5. Reliable Sprinkler Corp.

B. All sprinklers shall be adjustable, glass bulb, automatic sprinklers with ½ inch orifice and 5.6 K-factor unless noted otherwise. Type of sprinkler head shall be as indicated on the plans and in accordance with the following.

C. Sprinkler bodies shall be die-cast brass, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation.

D. Unless noted otherwise, ordinary temperature rated sprinkler heads shall be used throughout the building.

E. Where sprinklers will be installed in close proximity to heat sources and special locations, as identified in NFPA 13, temperature ratings shall be in accordance with the requirements of NFPA 13

F. Where plans call for extended coverage sprinkler heads coordinate coverage requirements with required pressure and K-factor.

G. Spare Sprinklers: The Sprinkler Contractor shall furnish spare automatic sprinklers in accordance with the requirements of NFPA for stock of extra sprinklers. The sprinklers shall be packed in a suitable container and shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. The Sprinkler Contractor shall furnish no less than two special sprinkler wrenches, or at least one wrench for each container or sprinkler box, whichever is greater.

H. In areas where sprinkler heads are subject to physical damage, provide sprinkler guard assembly over head, finish to match sprinkler finish. This shall include but not limited to the following locations.
1. Heads in elevator shafts.
2. Heads under lower rakes of stairways.
3. Heads in electrical rooms, boiler rooms and other mechanical rooms.
4. Heads installed 7’-0” or less above finished floors.

2.2 ALARM CHECK VALVES

A. Manufacturers:
1. Viking.
2. Tyco.
3. Victaulic.
4. Grinnell Corp.
5. Reliable Sprinkler Corp.

B. Wet Pipe Alarm Valve:
   1. Check type valve with Nitrile seat o-ring aluminum bronze clapper with EPDM seal to automatically actuate electrically and hydraulically operated alarms, with pressure retard chamber and variable pressure trim. Valve internal components shall be replaceable without removing valve from the installed position. Valve shall be Series 751 as manufactured by Victaulic Co or engineer approved equal.
   2. Provide retard chamber as part of wet alarm valve trim to allow for pressure fluctuations. Retard chamber shall be Victaulic Series 752 or engineer approved equal by manufacturers listed above. Provide all other trim as recommended by the manufacturer.
   3. Alarm check valve assembly shall allow discharge of one or more sprinklers to activate electric and hydraulic alarms.

2.3 FIRE DEPARTMENT HOSE VALVES AND FORWARD FLOW TEST HEADER

A. Manufacturers:
   1. Kennedy.
   2. Fairbanks.
   3. Stockham.
   4. Victaulic.
   5. Nibco.

B. Hose Connection Valves: Angle type; brass with chrome plated finish; 2-1/2 inch size, thread to match fire department hardware, 300 psi working pressure, with threaded cap and chain of chrome plated finish.

C. Hose Valves for Backflow Preventer / Forward Flow Test Header: Straight type; brass with chrome plated finish; (4) 2-1/2 inch size, thread to match fire department hardware, 300 psi working pressure, with threaded cap and chain of chrome plated finish.

2.4 PIPING SPECIALTIES

A. Manufacturers:
   1. Potter.
   2. Potter-Roemer.
   3. System Sensor.
   4. Victaulic.
   5. Viking.

B. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch, 120 volt with weatherproof back box.

C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two form C contacts; rated 10 amp at 120 volt.

D. Valve Tamper Supervisory Switch: Two form C contacts; rated 10 amp at 120 volt. UL listed and FM approved. Up to 2” – Potter Model PCVS-1. Over 2" switch shall be Potter Model OSYSU-2.

E. Pressure Switch: ½ inch male pressure connection to alarm valve riser and actuated by any flow of water in excess of one sprinkler. Maximum pressure rating 175 psi, weather-proof with tamper resistant screws, rated 10 amps at 120 volt.

F. Pressure Gage: Rated for 300 psi use, 3-1/2” in diameter.

2.5 FIRE DEPARTMENT CONNECTION

A. Fire department connection shall be 4” stortz, polished brass, single clapper, flush mounted. Provide with polished brass identification plate and polished chrome alloy cap.

B. The fire department connection shall be constructed of cast brass with brass clapper, brass swivel couplings and a brass hinge pin. The words “AUTO SPKR” and “F.D. Conn” shall be cast in raised letters on the body.

C. Fire department connection threads shall match the local fire departments standard.

D. Drain: 3/4 inch automatic drip, install at low point after check valve, pipe to building exterior.

E. Provide a 90-degree elbow with drain connection at each fire department connection to allow for drainage in areas exposed to the building exterior to prevent freezing. Elbow shall be Victaulic #10-DR.

PART 3 EXECUTION

3.1 PREPERATION

A. Coordinate work of this Section with other affected work.

B. Prepare piping connections to equipment with grooved joint couplings, flanges, or unions.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturers instructions.

B. Impairments to the existing water supplies shall be minimized. All work shall be complete before making the final connections to the existing water supplies. The Contractor shall notify the owners representative before impairing any fire protection equipment.

C. The Contractor shall maintain a clean and orderly site during the installation of the sprinkler system. Materials shall not be stored in the halls or other public areas.

D. Cutting, welding and other hot work shall not be permitted without permission from the building owner. Contractor shall provide a fire watch for one hour after all welding

E. The required tests shall be witnessed by the Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect/Engineer.

F. Provide reduced pressure backflow preventer assembly at sprinkler system water source connection. Install a drain line from the air gap fitting and terminate at the nearest floor drain. The backflow preventer shall be installed at a minimum height to allow installation of the air gap fitting, but shall not be installed at more than 5’0” above finished floor for maintenance.

G. Locate fire department connection with sufficient clearance from walls, obstructions, etc., to allow full swing of fire department wrench handle. Coordinate the exact location of the

fire department connection with the local fire officials. Installation shall conform to the local fire officials requirements.

H. Installation of Alarm Valves: Install a drain line from the drain connection to the nearest floor drain. Install a test line from the test connection to the exterior of the building. Provide a splash block. Provide gate valves at each line. Minimum alarm valve riser shall be 4-inch.

I. Locate alarm gong on exterior of building wall at main entry to the building

J. Center heads in two directions in ceiling tile and provide piping offsets as required.

K. Sprinkler Bulb protector must remain in place until the sprinkler is completely installed. Remove the bulb protector by hand after installation and before the system is placed in service. (Do not use any tools to remove the bulb protector.)

L. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

M. Coordinate flow switches, tamper switches, and all other sprinkler devices with the fire alarm system.

N. Provide wire guards on sprinklers as indicated on drawings.

O. Place pipe runs to minimize obstruction to other work.

P. Install piping in concealed spaces above finished ceilings.

Q. Pipe and fitting shall be installed per the manufacture’s installation requirements. The fire protection contractor shall furnish all materials necessary to meet these requirements including but not limited to hangers, support, insulation, shields, sleeves and power supplies.

R. Require test be witnessed by Fire Marshal, Authority having jurisdiction and Owner's insurance underwriter.

3.3 INSTALLATION HOSE CONNECTIONS

A. Install in accordance with NFPA 13.

B. All hose connection valves shall be installed in cabinets.

C. Install cabinets plumb and level. Secure to adjacent surfaces. Establish top of cabinet (inside horizontal) surface 60 inches above finished floor.

D. Install hose station valve in cabinet at 60 inches above floor. Install hose-connection valve under hose station valve and not closer than 4 inches from side or bottom of cabinet.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Verify signal devices are installed and connected to fire alarm system.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

3.6 IDENTIFICATION

A. Provide and apply signs to control, drain, test and alarm valves to identify their purpose and function.

B. Provide and permanently attach hydraulic calculations data nameplate at the controlling valve for the sprinkler system. Provide lettering size and style from NFPA's suggested styles.

3.7 TESTING

A. Hydrostatic tests must be performed on the entire sprinkler piping system, as required by NFPA 13.

B. Refer to Section 21 05 00 - Common Work Results for Fire Suppression.

END OF SECTION

SECTION 220400

GENERAL CONDITIONS FOR PLUMBING TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

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

B. This section applies to certain sections of Division 26, "Electrical," and this section applies to all sections of Division 22, "Plumbing" of this project specification unless specified otherwise in the individual sections.

C. The Drawings of other trades (Architectural, Structural, Landscape, Civil, Mechanical, Fire Protection and Electrical) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

1.2 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

1.3 INTENT

A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation. Provide all parts necessary for the intended use, fully complete and operational, and installed in professional manner in accordance with the design intent.

B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.

C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.

D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.4 DEFINITIONS

A. “Approved equal” also known as “alternative” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

B. No Exceptions Taken – reviewed and determined to be in general conformance with contract documents.

C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

D. “Finished” refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

E. “Furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.

F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

G. “Install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.

H. "Lead Free" shall mean not more than .25% in the wetted surface area.

I. No Exceptions Taken – reviewed and determined to be in general conformance with contract documents.

J. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

K. “Provide” shall mean furnish (or supply) and install as necessary.

L. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

M. Remove: The term “remove” means “to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”

N. Special Warranties: The term “Special Warranties” are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

O. Standard Product Warranties: The term “Standard Product Warranties” are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

P. “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.

Q. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."

R. “Wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

1.5 CONTRACT DOCUMENTS

A. The two dimensional drawings govern the construction. They show the design intent and are part of the Contract Documents. BIM models are not part of contract documents. They are developed for convenience only.

B. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

C. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

D. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.

1.6 DISCREPANCIES IN DOCUMENTS

A. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

B. Where Drawings or Specifications conflict or are unclear, submit clarification request in writing before Award of Contract. Otherwise, Architect's interpretation of Contract

Documents shall be final, and no additional compensation shall be permitted due to discrepancies or un-clarities thus resolved.

C. Where Drawings or Specifications do not coincide with manufacturers' recommendations or with applicable codes and standards, submit clarification request in form of an RFI before installation. Otherwise, make changes in installed work required for compliance with manufacturer instructions or codes and standards within Contract Price.

D. Where insufficient information exists in the documents to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements, where notification required by Paragraph (B) above has not been submitted, provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in professional manner either concealed or exposed in accordance with the design intent.

E. Where discrepancies exist between the mechanical, plumbing, fire protection, and electrical drawings in regards to what trade owns disconnects or starters, the discrepancy shall be brought to the Architect’s attention in accordance with paragraph (B) above. If the scope is not resolved prior to the Award of Contract, Division 26 shall provide such items.

1.7 SURVEYS AND MEASUREMENTS

A. Before submitting the Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which work will be installed. This Contract includes all modifications of existing systems required for the installation of new equipment. This Contract includes all necessary offsets, transitions and modifications required to install all new equipment in existing spaces. All new and existing equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions made, any omissions or errors made as a result of their failure to become fully familiar with the existing conditions at the site and the Contract Documents.

B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

1.8 CODES AND STANDARDS

A. Reference Standard Compliance
1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters

Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.

2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

B. Wherever Codes and/ or standards are mentioned in these specifications, the latest applicable edition or revision of the local building or life safety code shall be followed.

C. The following Standards shall be used where referenced by the following abbreviations:

ACGIH	American Conference of Governmental Industrial Hygienists
AGA	American Gas Association
AIA	American Institute of Architects
ANSI	American National Standards Institute
API	American Petroleum Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CGA	Compressed Gas Association
CSA	Canadian Standards Association
CISPI	Cast Iron Soil Pipe Institute
EJMA	Expansion Joint Manufacturing Association
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification

HIS	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	Insurance Services Office
MCAA	Mechanical Contractors Association of America
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSC	National Safety Council
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SDWA	Safe Drinking Water Act
UL	Underwriters' Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.9 PERMITS AND FEES

A. The Contractor shall give all necessary notices, obtain all permits; and pay allother costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.10 EQUIPMENT EQUIVALENTS AND SUBSTITUTIONS

A. Certain manufacturers of material, apparatus or appliances are indicated in the drawings and specifications for this project. These items have been used as the basis of design,

and as a convenience in fixing the minimum standard of quality, finish and design that is required. If the Contractors uses an “approved equal” alternative to the basis of design, and if the features of that alternative have an impact on other components of the Project, the Contractor shall include the necessary adjustments in those components, whether for architectural, structural, mechanical, electrical, fire protection, or any other elements, plus any adjustments for difference in performance.

B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for Architect and Engineer review.

C. Where the Contractor proposes to use an item that is different from the basis of design in the Drawings and specifications, and that will require the redesign of the structure, partitions, foundations, piping, wiring or any other component of the mechanical, electrical, or architectural layout, the Contractor shall provide the necessary redesign of those components.

D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the basis of design scheduled equipment or materials as hereinafter specified or shown on the drawings, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution, equivalent or a non-approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

E. If an alternative or substitute item results in a difference in quantity and arrangement of structure, piping, ductwork, valves, pumps, insulation, wiring, conduit, and equipment from that specified or indicated on the Drawings, the Contractor shall furnish and install any such additional equipment required by the system, at no additional cost to the Owner including any costs added to other trades due to the equivalent change from the basis of design detailed in the drawings or included within the specifications.

F. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
   1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
   2. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
      a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
      b. Samples, where applicable or requested.

c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.

d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.

e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.

f. Cost information, including a proposal of the net change, if any in the Contract Sum.

g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.

h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.

i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.

1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.

2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.11 SUBMITTAL PROCEDURES

A. Provide Submittals in accordance with the requirements of Division 01 and as indicated in the following.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
   1. Allow ten business days for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
   2. If an intermediate submittal is necessary, process the same as the initial submittal.
   3. Allow ten business days for reprocessing each submittal.
   4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
   1. Include the following information on the label for processing and recording action taken.
      a. Project name.
      b. Date.
      c. Name and address of Engineer.
      d. Name and address of Contractor.
      e. Name and address of subcontractor.
      f. Name and address of supplier.
      g. Name of manufacturer.
      h. Number, title and paragraph of appropriate Specification Section.
      i. Drawing number and detail references, as appropriate.

E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.

G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

H. LEED Submittals: Provide manufacturers' or third-party certification of testing to and compliance with the California Department of Public Health (CDPH) Standard method v1.2-2017, that includes the following information:
1. The exposure scenario used to determine compliance.
2. The range of total VOCs after 14 days, measured as specified in the CDPH Standard Method v1.2:
3. 0.5 mg/m^3 or less;
4. Between 0.5 and 5.0 mg/m^3; or
5. 5.0 mg/m^3 or more
6. Laboratory accreditation under ISO/IEC 17025.
7. Claims of compliance for wet-applied products must state the amount applied in mass per surface area
8. Provide MSDS or other manufacturer documentation with disclosure of VOC content for all wet-applied products.
9. Complete "LEED Materials Documentation Sheet" with IEQc2 information for adhesives/sealants installed within the waterproofing membrane.

1.12 SHOP DRAWINGS

A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated plumbing layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review all shop drawings to be incorporated in the Plumbing Contract.

C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers’ names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, performance cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.

E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.

G. “No Exception Taken” rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.

H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.

I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.

J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to bidding to allow for issuance of an Addendum.

K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

L. All submittals shall be made in electronic PDF format with searchable OCR (Optical Character Recognition) format. This excludes scanned and faxed materials.

1.13 COORDINATION DRAWINGS AND BIM MODEL

A. Coordination drawings are required for all fire protection, plumbing, mechanical and electrical trades. The content and procedures described in Division 01 shall be followed, with the additional requirements specifically for the plumbing and electrical trades as described in this Section. If a BIM model is not used on this project, the below requirements shall be accomplished in CAD.

B. Prepare coordination drawings in accordance with Division 01 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
      a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.

b. Equipment connections and support details.
c. Exterior wall and foundation penetrations.
d. Fire-rated wall and floor penetrations.
e. Sizes and locations of required concrete pads and bases.

C. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

D. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

E. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

F. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.

G. Work shall not be performed until coordination drawings have been approved by the architect and engineer.

H. Electronic copies of the MEP floor plans and/or BIM model are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. If the Contractor elects to obtain the Engineers electronic files an Electronic Drawing File Release Form must be submitted. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic Drawing File Release Form, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the Electronic Drawing File Release Form is appended to the end of this specification section

I. Review by Engineer of coordination drawings is limited to confirming that requirements for coordination and preparation of plans have been complied with by the Contractor and shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with Architectural, Structural, Mechanical, Electrical and other related work.

1.14 COORDINATION WITH OTHER DIVISIONS

A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.

B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.

C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.

D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

E. The two dimensional drawings are diagrammatic. They indicate general arrangements of mechanical systems and other work, and are intended to convey sufficient information for skilled contractors and tradespeople to furnish and install complete systems. They are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, provide all other components and materials to make the systems fully complete, coordinated with other systems and the structure and space available, and operational. Similarly, the drawings do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades in order to avoid interferences and to meet ceiling heights and other Architectural requirements. Establish and provide offsets, changes in direction, and exact routings to coordinate all systems. Where conflicts or potential conflicts exist and engineering guidance is desired, submit a “Request for Information” (RFI).

F. Controls contractor shall coordinate and sequences of operation with all other trades as necessary to provide a complete and functioning system.

1.15 QUALITY CONTROL

A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled tradespeople, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

E. All labor for installation of plumbing systems shall be performed by experienced, skilled tradespeople under the supervision of a licensed journeyman foreman. All work shall be

of a quality consistent with good trade practice and shall be installed in a neat, professional manner. The Engineer reserves the right to reject any work which, in their opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.16 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.

B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.17 TEMPORARY UTILITIES

A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. First Aid Supplies: Comply with governing regulations.

D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.

E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
   1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.

F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.

G. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and

minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

H. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.18 EQUIPMENT ACCESS

A. Appliances, controls devices, valves and accessories that utilize energy shall be accessible for inspection, service, repair and replacement without disabling the function of a fire-resistance-rated assembly or removing permanent construction, other appliances, venting systems or any other piping not connected to the appliance being inspected, serviced, repaired or replaced. A level working space not less than 30 inches deep and 30 inches wide shall be provided in front of the control side to service an appliance.

1.19 PROJECT PHASING

A. Work under each Section shall include all necessary temporary connections, equipment, piping, heating, temperature control work, fire stopping, water heaters, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain existing systems operational or to accommodate the construction phasing of the project.

1.20 PROTECTION OF MATERIALS AND EQUIPMENT

A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or tradespeople and shall include making good all damage thus caused.

B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and

protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by tradespeople or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

E. LEED Requirements:

1. For field applications that are inside the weatherproofing membrane: Adhesives/sealants must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario. The default scenario is the private office scenario.
2. All adhesives/sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.

1.21 ADJUSTING AND TESTING

A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.

B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing that the equipment was installed according to manufacturer’s recommendations and is operating as intended by the manufacturer.

1.22 CLEANING

A. The Contractor shall thoroughly clean and flush all piping and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.

B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

C. During the course of construction, all pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.

D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or

grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
   1. Remove labels that are not permanent labels.
   2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
   3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
   4. Wipe surfaces of plumbing equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition.

F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.

G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.23 OPERATING AND MAINTENANCE

A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner’s representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days’ notice to the Owner and the Engineer in advance of this period.

B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

D. An authorized manufacturer’s representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; controls, water heaters, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.

E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

F. Demonstration shall be recorded on USB Flash drive and turned over to the Owner. Video recording shall be done in a professional manner with quality video (1080p resolution) and clear audible sound.

1.24 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and requirements listed below. The Contractor shall prepare three (3) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.

B. In addition to the booklets, provide an electronic pdf organized by types of equipment with bookmarks. Size of files shall be kept to under 30 Megabytes. If over 30MB, provide multiple files.

C. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing and operating instructions including lubrication charts and schedules.
5. Emergency and safety instructions.
6. Spare parts list.
7. Copies of warranties.
8. Wiring diagrams.
9. Recommended "turn around" cycles.
10. Inspection procedures.
11. Approved Shop Drawings and Product Data.
12. Equipment Start-up Reports.
13. Balance reports.

D. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, bearing number, etc. Schedule shall include maintenance to be done and frequency.

E. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.25 ACCEPTANCES

A. The equipment, materials, quality, design and arrangement of all work installed under the Plumbing Sections shall be subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, the Plumbing Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Plumbing Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.

C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner's representative.

D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Plumbing Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.

F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.26 RECORD DRAWINGS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
   1. Dimensional change
   2. Revision to drawing detail
   3. Location and depth of underground utility
   4. Revision to pipe routing
   5. Revision to electrical circuitry
   6. Actual equipment location

7. Pipe size and routing
8. Location of concealed internal utility
9. Changes made by Change Order
10. Details not on original Contract Drawing
11. Information on concealed elements which would be difficult to identify or measure later

C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.

D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.

E. Note related Change Order numbers where applicable.

F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

G. Final record documents shall be prepared in the AutoCAD and Revit and CD Rom of all drawings. All field changes shall be drafted by the Contractor. In addition, a set of pdf files and a clean set of reproducible paper copies shall be turned over to the Owner at the completion of the work.

1.27 WARRANTIES AND BONDS

A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers' standard warranties on products and special warranties are to be included:
1. General close-out requirements included in Division 01.
2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions-02 through -50.
3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.28 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement.

The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
   1. Refer to individual Sections of Divisions-02 through -50 for specific content requirements, and particular requirements for submittal of special warranties.

J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
   1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed

description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.

2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.29 GUARANTEES

A. The Contractor shall guarantee all material and installation quality under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or installation quality shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

1.30 PROJECT CLOSE-OUT

A. Submit specific warranties, quality bonds, maintenance agreements, final certifications and similar documents in accordance with Division 01.

B. Deliver tools, spare parts, extra stock, and similar items.

C. Complete start-up testing of systems, including measuring and documenting all required startup checklist requirements documented in installation and maintenance instructions by the equipment manufacturer, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

D. Complete final clean up requirements, including touch-up painting of equipment provided by Division 22. Touch-up and otherwise repair and restore marred exposed finishes.

E. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued. Contractor shall submit written response to each corrective item including specific photos prior to final Engineering inspection.

1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION

Electronic Drawing File Release Form

DELIVERY OF ELECTRONIC FILES FOR: _____
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Contractor covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Contractor further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Contractor agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Contractor agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Contractor be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ _____
Contractor's Signature Date

_____
Company - Title

_____ _____
Architects' Signature Date

_____
Firm - Title

_____ _____
Owner's Signature Date

_____
Company - Title

SECTION 220500

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Tags.
3. Pipe markers.
4. Ceiling tacks.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements.

B. Section 22 0400 – General Conditions for Plumbing Trades.

C. Section 22 0500 – Common Work Results for Plumbing.

D. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.

E. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

F. Section 22 0553 - Identification for Plumbing Piping and Equipment.

G. Section 22 0709 - Plumbing Insulation

H. Section 22 1005 – Plumbing Piping.

I. Section 22 1123 – Fuel Gas Piping.

J. Section 22 6013 – Medical Gas and Vacuum Systems.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. American Society of Mechanical Engineers:
1. ASME B31.1 - Power Piping.
2. ASME B31.9 - Building Services Piping.

B. ASTM International:
1. ASTM E84-18b - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction Materials.
3. ASTM E1966-15 - Standard Test Method for Fire-Resistive Joint Systems.

C. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

D. Underwriters Laboratories Inc.:
   1. UL 263 - Standard for Fire Test of Building Construction and Materials
   2. UL 723 – Standard for Tests for Surface Burning Characteristics of Building Materials.
   3. UL 1479 – Standard for Fire Tests of Penetration Firestops.
   4. UL 2079 – Standard Tests for Fire Resistance of Building Joint Systems.
   5. UL - Fire Resistance Directory.

1.4 SUBMITTALS

A. See Division 01 – Requirements for Submittals.

B. Shop Drawings: Submit for piping and equipment identification list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Shop Drawings (Identification): Submit list of wording, symbols, letter size, and color coding for identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Manufacturer's Installation Instructions: Submit special procedures.

E. Product Data: Product Data for Pipe and Equipment Identification: Submit for mechanical identification manufacturers catalog literature for each product required.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.

B. Installer: Company specializing in performing work of this section with minimum three years of experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Division 01 - General Requirements.

B. Protect equipment from exposure by leaving factory coverings and packaging in place until installation.

1.8 WARRANTY

A. See Division 01 - General Requirements.

1.9 CLOSEOUT SUBMITTALS

A. See Division 01 - General Requirements.

B. Project Record Documents: Record actual locations of identification devices.

PART 2 PRODUCTS

2.1 IDENTIFICATION FOR PIPING AND EQUIPMENT

A. Manufacturers:
1. Craftmark Identification Systems
2. Safety Sign Co.
3. Seton Identification Products

B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light background color.

C. Plastic Tags: Laminated three-layer plastic with engraved black letters on light background color, minimum 1-1/2 inches diameter.

D. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Color and Lettering: Conform to ASME A13.1.

E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Color and Lettering: Conform to ASME A13.1.

F. Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.2 NAMEPLATES

A. Manufacturers:
1. Craftmark Identification Systems
2. Safety Sign Co.
3. Seton Identification Products

B. Product Description: Laminated three-layer plastic with engraved letters.
1. Letter Color: White.
2. Letter Height: 1/4 inch
3. Background Color: Black.
4. Plastic: Conform to ASTM D709.

2.3 TAGS

A. Plastic Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products

2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.

B. Metal Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

C. Information Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

D. Tag Chart: Typewritten letter size list of applied tags and location. Provide as an excel or word doc in addition to a pdf file and documentation on final Record Drawings.

2.4 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:
1. Manufacturers:
a. Seton
b. Northtown
c. Kolbi
2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
3. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with color code as follows:

a. Natural Gas: Yellow with black letters.
b. Toxic and Corrosive Fluids: Orange with black letters.
c. Flammable Fluids: Yellow with black letters.
d. Heat traced piping: to match the color code of the fluid or gas being used.

2.5 CEILING TACKS

A. Manufacturers:
1. Seton
2. Northtown
3. Kolbi

B. Description: Steel with 3/4 inch diameter color-coded head.

C. Color code as follows:
1. Plumbing valves: Green.

PART 3 EXECUTION

3.1 INSTALLATION - PIPING AND EQUIPMENT IDENTIFICATION

A. Install plastic nameplates with adhesive.

B. Install plastic tags with corrosion resistant metal chain.

3.2 INSTALLATION - IDENTIFICATION

A. Install identification of heat traced pipe every 20 feet at minimum.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify equipment with plastic nameplates. Identify in-line equipment and other small in line devices with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with

axis of piping. Locate identification not to exceed 10 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

K. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 220513

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes single- and three-phase motors for application on equipment provided under other sections and for motors furnished loose to Project.

B. Related Sections:
1. Division 22 - Plumbing
2. Division 26 - Electrical.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.

C. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Division 01 - Submittal Procedures.

B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 MOTORS

A. Manufacturers:
1. Baldor Electric.
2. General Electric.
3. Marathon Electric.
4. Reliance Electric

B. Motors 3/4 hp and Larger: Three-phase motor except where specifically noted otherwise.

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

D. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

E. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
1. 60 Hertz except where specifically noted otherwise.
2. Enclosure: Meet conditions of installation.
3. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. Insulation System: NEMA Class B or better.
5. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
6. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
7. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
8. Sound Power Levels: Conform to NEMA MG 1.

F. Single Phase Motors:
1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. 60 Hertz except where specifically noted otherwise
3. Starting Torque: Exceeding one fourth of full load torque.
4. Starting Current: Up to six times full load current.
5. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.2 MISCELLANEOUS SPECIALTIES

A. EC Motors shall be an electronically commutated motor rated for continuous duty and furnished either with internally mounted potentiometer speed controller or with leads for connection to 0-10 VDC external controller.

2.3 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

2.4 EFFICIENCY

A. All motors shall be “Premium Efficiency” with minimum efficiencies as required by the local utility company’s current rebate program. The nominal efficiency shall be stamped on the nameplate in accordance with NEMA Standard MG. 1.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

B. Install engraved plastic nameplates in accordance with Section 26 05 53.

C. Ground and bond motors in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements and Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

END OF SECTION

SECTION 220516

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Flexible pipe connectors.
2. Expansion joints.
3. Expansion compensators.
4. Pipe alignment guides.
5. Swivel joints.
6. Pipe anchors.

B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 00 – Common Work Results for Plumbing.
3. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
4. Section 22 10 05 –Plumbing Piping.
5. Section 22 11 23 – Facility Natural-Gas Piping.
6. Section 22 6013 – Medical Gas and Vacuum Systems.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.9 - Building Services Piping.
2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

1.3 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:
1. Installation Temperature: 50 degrees F.
2. Domestic Hot Water: 140 degrees F.
3. Safety Factor: 30 percent.

1.4 SUBMITTALS

A. Division 01 - Submittal Procedures.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Include shop drawing information for piping expansion compensation in shop drawings for piping system specified in Section

C. Product Data:
   1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Design Data: Indicate criteria and show calculations.

E. Manufacturer's Installation Instructions: Submit special procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.

H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

C. Operation and Maintenance Data: Submit adjustment instructions.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. All pre-manufactured expansion fittings and loops installed on the domestic water system shall meet the requirements of SDWA 1417.

C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:
1. Metroflex
2. Mason
3. Vibration Eliminator
4. Novia.

B. Steel Piping:
1. Inner Hose: Carbon Steel.
2. Exterior Sleeve: Single braided .
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint: As specified for pipe joints.
5. Size: Use pipe-sized units.
6. Maximum offset: 1 inch on each side of installed center line.

C. Copper Piping:
1. Inner Hose: Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint: As specified for pipe joints.
5. Size: Use pipe sized units.
6. Maximum offset: 1 inch on each side of installed center line.
7. Maximum lead content shall be.25%.

2.2 EXPANSION JOINTS

A. Manufacturers:
1. Metroflex
2. Mason
3. Vibration Eliminator

B. Stainless Steel Bellows Type:
1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 3 inch.
3. Maximum Extension: 1/4 inch.
4. Joint: As specified for pipe joints.
5. Size: Use pipe sized units.
6. Application: Steel piping 3 inch and smaller.

C. Copper with Packed Sliding Sleeve:
   1. Maximum Temperature: 250 degrees F.
   2. Joint: As specified for pipe joints.
   3. Size: Use pipe sized units.
   4. Copper or steel piping 2 inches and larger.
   5. Application: Copper or steel piping 2 inch and larger.

2.3 ACCESSORIES

A. Manufacturers:
   1. Metroflex
   2. Mason
   3. Vibration Eliminator
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

C. Swivel Joints: Fabricated steel Bronze Ductile Iron Cast steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install Work in accordance with ASME B31.9

B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation including pumps. Refer to Section 22 05 48. Provide line size flexible connectors.

C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.

E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required per Part 1 of this specification. Refer to Section 22 05 29 for pipe hanger installation requirements.

F. Provide pipe expansion fittings and accessories at all building expansion joints.

3.2 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.

B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

SECTION 220517

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe sleeves.

B. Stack sleeves fittings.

C. Sleeve-seal systems.

D. Mechanical sleeve seals.

E. Foundation wall sleeves.

1.2 RELATED REQUIREMENTS

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

B. Division 07 – Thermal and Moisture Protection.

C. Section 22 07 00 – Plumbing Insulation.

D. Section 22 2005 – Plumbing Piping

1.3 REFERENCE STANDARDS

A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2016.

B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

1.4 SUBMITTALS

A. See Division 01 - General Requirements, for submittal procedures.

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

B. Installer Qualifications: Company specializing in performing work of the type specified this section.
   1. Minimum three years experience.

C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

PART 2 PRODUCTS

2.1 SLEEVES

A. Materials
1. Cast-Iron Pipe Sleeve: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated
2. Galvanized Steel Pipe Sleeve: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
3. Galvanized-Steel Sheet Sleeve: 0.0239-inch thickness; round tube closed with longitudinal joint.

2.2 STACK SLEEVE FITTINGS

A. Manufacturers
1. Zurn Industries, LLC
2. Jay R. Smith Mfg. Co.
3. MIFAB, Inc.
4. Josam

B. Stack Sleeve Fitting
1. Galvanized cast iron sleeve with integral flashing flange. Provide underdeck clamp where required.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. Flexicraft Industries; PipeSeal.
2. Metraflex
3. Link-Seal

B. Modular/Mechanical Seal:
1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

2.4 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. Fernco
3. BWM

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

C. Mechanical sleeve seals shall be installed at all grade to floor pipe penetrations, grade to wall pipe penetrations and exterior of building to wall pipe penetrations.

2.5 FOUNDATION WALL SLEEVES

A. Where buried piping penetrates foundation walls completely below grade on all sides, provide Schedule 80 PVC sleeve; minimum 2” larger than OD of piping.

PART 3 EXECUTION

3.1 GENERAL

A. Lay out penetration and sleeve openings in advance, to permit provision in work. Coordinate work with architectural and structural work. Set sleeves in forms before concrete is poured. Provide remedial work where sleeves are omitted or improperly placed. Remedial work includes core drilling (see requirements below) for penetrations if walls are poured, or otherwise constructed, without required sleeves. Provide core drilling (see requirements below) of existing construction. Do not penetrate structural members without Structural Engineer’s/Architect's written approval.

B. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

F. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install chrome plated steel plastic stainless steel escutcheons at finished surfaces.

H. Sleeve installation shall meet NFPA-101 requirements, UL rated assemblies requirements, and materials requirements of these specifications. Submit a list of the UL listed details that the Contractor intends on using on this project in all rated assemblies.

I. Where pipes passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.

J. Identify unused sleeves and slots for future installation. Fill slots, sleeves and other openings in floors or walls if not used. Fill spaces in openings after installation of pipe. Fill for floor penetrations shall prevent passage of water, smoke, fire, and fumes. Fill shall be fire resistant in fire floors and walls, and shall prevent passage of air, smoke and fumes.

K. Do not support piping risers or conduit on sleeves.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 for materials.

M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements. Verify final equipment locations for roughing-in.

N. Structural Considerations: Do not penetrate building structural members unless indicated.

3.2 APPLICATIONS

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls Above Grade:
      a. Cast-iron pipe sleeves or galvanized-steel pipe sleeves.
   2. Exterior Concrete Walls and Concrete Slabs-on-Grade:
      a. Sleeves shall be waterproof. Seal with mechanical sleeve seals
   3. Concrete Slabs above Grade:
      a. Galvanized-steel-pipe sleeves, or stack sleeve fittings
   4. Interior Partitions:
      a. Cast iron pipe sleeves, galvanized-steel-pipe sleeves, or galvanized-steel-sheet sleeves.
   5. Floors with membrane waterproofing:
      a. Stack sleeve fittings.

3.3 SLEEVE INSTALLATION

A. Install steel sleeves for piping passing through penetrations in floors, fire rated partitions, walls with acoustical treatment and spaces requiring differential pressure controls (future isolate room, all spaces at OR Suite and SPD Suite.

B. 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.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. 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.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   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 joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 – Thermal and Moisture Protection

E. Sleeves for insulated pipe in non-fire rated construction shall accommodate continuous insulation without compression.

F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified Division 07 – Thermal and Moisture Protection

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

B. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

C. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 – Thermal and Moisture Protection

D. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

E. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

F. Using grout, seal the space around outside of stack-sleeve fittings.

G. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 – Thermal and Moisture Protection.

3.3 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.

C. Position piping in center of sleeve.

D. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve.

E. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

F. Install in accordance with manufacturer's recommendations.

3.4 CORE DRILLING

A. Core drilling shall be avoided in new construction. Set sleeves prior to installation of structure for passage of pipes, conduit and ducts. Where core drilling is unavoidable (e.g. when individual sleeves are not installed or incorrectly located) or required by renovation projects, locate required openings prior to coring and submit locations for review.

B. Coordinate openings with other Divisions.

C. Do not disturb existing systems. Protect areas from damage.

D. Thoroughly investigate existing conditions in vicinity of required opening prior to coring.

END OF SECTION

SECTION 220523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Gate valves.
2. Ball valves.
3. Butterfly valves.
4. Check valves.
5. Globe valves.
6. Pressure reducing valves.
7. Pressure relief valves.
8. Strainers.
9. Reduced pressure zone assembly / backflow preventers.
10. Manual balancing valves.
11. Autoflow / automatic balancing valves.
12. Thermostatic mixing valves

B. Related Sections:
1. Division 01 – General Requirements.
2. Section 22 04 00 – General Conditions for Plumbing Trades
3. Section 22 05 00 – Common Work Results for Plumbing
4. Section 22 10 05 – Plumbing Piping
5. Section 22 07 00 - Plumbing Insulation.

1.2 REFERENCES

A. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

B. Safe Drinking Water Act:
1. SDWA 1417 - Reduction of Lead in Drinking Water.

1.3 SUBMITTALS

A. Division 01 – General Requirements: Requirements for submittals.

B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 - General Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of valves

C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

B. All valve manufacturers shall demonstrate that valve products have been certified per NSF/ANSI Standard 372.

C. All valves installed on the domestic water system shall have labeling of lead content engraved on the valve body.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum 3 years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - General Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Division 01 – General Requirements: Environmental conditions affecting products on site.

B. Do not install valves underground when bedding is wet or frozen.

1.9 WARRANTY

A. Division 01 – General Requirements: Requirements for warranties.

PART 2 PRODUCTS

2.1 GATE VALVES

A. Manufacturers:
1. Apollo
2. Milwaukee Valve Co.
3. NIBCO, Inc.
4. American Valve Co.
5. Watts

B. 2 inches and Smaller: MSS SP 80, Class 300, bronze body, bronze trim, lead free, threaded bonnet, non-rising stem, hand-wheel, inside screw, solid wedge disc, solder ends, based on Milwaukee Valve Company Model # UP115.

C. 2 1/2 inches and Larger: MSS SP 70, Class 175, cast iron body, bronze trim, bolted bonnet, rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends, based on Milwaukee Valve Company F-2885-FP. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.2 BALL VALVES

A. Manufacturers:
1. Apollo
2. Milwaukee Valve Co.
3. NIBCO, Inc.
4. American Valve Co.
5. Watts

B. 2 inches and Smaller: MSS SP 110, 600 psi WOG, two piece bronze body, lead free, type 316 stainless steel ball, full port, teflon seats, stainless steel blow-out proof stem, solder ends with lever handle, Milwaukee Valve Company Model #UPBA450S.

2.3 BALL VALVES (Press Style)

A. Manufacturers:
1. Nibco Model # PC585-66-LF
2. Viega
3. Milwaukee Valve Company
4. Mueller.

B. 4 inches and Smaller: MSS SP 110, 200 psi rating at 250F, bronze, two piece body, lead free, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, press ends, lever handle,

C. Manufacturer of press fit valves shall be same manufacturer as press fit piping joints.

2.4 CHECK VALVES

A. Horizontal Swing Check Valves:
1. Manufacturers:
a. Apollo
b. Milwaukee Valve Co.
c. NIBCO, Inc.
d. American Valve Co.
e. Watts

B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body and cap, bronze seat, brass disc, solder ends, Milwaukee Valve Co. Model # 1509.

C. 2-1/2 inches and Larger: MSS SP 71, Class 125, iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.

2.5 CHECK VALVES (Press Style Fittings)

A. Spring Loaded Check Valves :
1. Manufacturers:
a. Nibco #PC-413-Y-LF
b. Viega
c. Milwaukee Valve Company
d. Mueller.
2. 2 inches and Smaller: MSS SP 139, 225 psi rating at 250F, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat.
3. Manufacturer of press fit valves shall be same manufacturer as press fit piping joints.

2.6 PRESSURE REDUCING VALVES

A. Manufacturers:
1. Watts.
2. Milwaukee Valve Co.
3. NIBCO, Inc.
4. American Valve Co.

B. Up to 2 Inches: Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, threaded ends, with strainer. Watts Model 223.

C. Over 2 Inches (50 mm): Ductile iron body, globe valve sty ASTM 536, Class 150, epoxy lined and coated, 316 stainless steel trim, copper and brass tubing and fittings, Buna-N elastomers, flanged, with strainer,20-175 psig reducing system. Watts Model LFF 115.

2.7 TEMPERATURE AND PRESSURE RELIEF VALVES

A. Manufacturers:
1. Watts Model LFN240.
2. Milwaukee Valve Co.
3. NIBCO, Inc.
4. American Valve Co.

B. Bronze or brass lead free body, 150 psig pressure rating, 75 to 150 psig pressure setting range, automatic reseating temperature and pressure relief, stainless steel thermostat tube, ASME rated.

2.8 STRAINERS

A. Manufacturers:
1. Spirax Sarco.
2. Watts.
3. NIBCO, Inc.
4. Milwaukee Valve Co
5. Apollo.
6. American Valve Co.

B. Size 2 inch and Under: Screwed cast iron body for 175 psig working pressure, Y pattern with 20 Mesh, stainless steel Type 304 perforated screen. Spirax Sarco Model IT.

C. Size 2-1/2 inch and Larger: Flanged cast iron body for 200 psig working pressure, Y pattern with 20 Mesh, stainless steel Type 304 perforated screen. Spirax Sarco Model CI or F.

2.9 REDUCED PRESSURE ZONE ASSEMBLIES / BACKFLOW PREVENTERS

A. Manufacturers:
1. Watts
2. Zurn
3. Febco
4. Ames
5. NIBCO

B. 2 inches and Smaller: ASSE 1013, AWWA C511-92, 175 psig maximum working pressure, lead free, cast copper silicon alloy body, double check with pressure differential relief valve between the two positive seating check valves. Provide with test cocks, quarter turn ball valves, air gap fitting and bronze inlet strainer. Watts Model LF909.

C. 2-1/2 inches and Larger: ASSE 1013, 125 psig max working pressure, lead free, stainless steel body and internal parts, stainless steel removable cover to access both check valves, thermoplastic check valves, flanged ends and double check with pressure differential relief valve between the two positive seating check valves. Provide with test cocks, two (2) cast iron OS&Y gate valves with flange connections, air gap fitting and cast iron strainer with flanged connections. Watts Model 994.

2.10 BACKFLOW PREVENTERS

A. Manufacturers:
1. Watts
2. Zurn
3. Febco
4. Ames
5. NIBCO

B. ½ inch and ¾ inch: ASSE 1012, 175 psig maximum working pressure, lead free, forged brass body, solder end connections, stainless steel internal parts and double check with intermediate atmospheric vent. Provide with union and ½" threaded drain connection. Watts Model 9D.

2.11 MANUAL BALANCE VALVES

A. Manufacturers:
1. Mason Model LL-TV
2. Armstrong.
3. Taco
4. TA Hydronics

B. Construction:
1. Low lead, Brass copper alloy (1/2"-2") or ASTM A536 ductile iron (2-1/2"-12") body, Y-pattern globe style, temperature and pressure test plug on inlet and outlet with check valves and screw on caps. Copper shall be solder or threaded ends.
2. Minimum of 4-360 degree handwheel turns for precise flow measurement, precise flow balancing, and shutoff eliminating the need for an additional isolation valve. EPDM O-ring seals, hidden memory feature with tamper-proof setting and digital readout. For insulation against heat loss or condensation, provide preformed rigid polyurethane insulation for sizes ½" through 6".

2.12 "AUTOFLOW" / AUTOMATIC BALANCING VALVES

A. Manufacturers:
1. Flow Design Inc/Autoflow
2. Nexus.
3. Griswold Controls
4. Macon
5. Nutech.

B. General:
1. Automatic flow control valve cartridges shall be fabricated of type 304 stainless steel and shall be factory calibrated to automatically control flow rates with ±5% accuracy over the control range of the valve.
2. The automatic flow control valve shall be permanently marked to show direction of flow; and shall be provided with a valve tag to indicate flow rate, model number and equipment served.
3. All automatic flow control valve cartridges shall be warranted by the manufacturer for a minimum period of five years.

2.13 THERMOSTATIC MIXING VALVES

A. Manufacturers:
1. Armstrong Brain
2. Powers -Watts
3. Leslie
4. Lawler
5. Symmons

B. Digital Mixing Valve:
   1. Digital mixing valve with integral RTD sensor.
   2. Maximum operating pressure of 200 psig.
   3. Maintain temperature setpoint down to 0 gpm.
   4. Auto shut-off on loss of water inlet flow.
   5. Programmable range of 65F to 180F.
   6. Valve body: lead free bronze or brass
   7. Check valves at inlets.
   8. 120 volt / 1 phase power to controller with plug in cord.

C. Standard Mixing Valve:
   1. Thermostatic control valve with removable cartridge.
   2. Stainless steel piston.
   3. Swivel action check stops.
   4. Integral strainer.
   5. Maximum operating pressure of 200 psig.
   6. High - low flow arrangement
   7. Valve body: lead free bronze or brass
   8. Cabinet: 16 gage primes coated steel for recessed mounting and keyed lock.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 – General Requirements: Verification of existing conditions before starting work.

B. Verify piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Piping drains: Install minimum 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers and at equipment.

D. Provide access doors where valves and fittings are not accessible. Coordinate size and location of access doors with Division 08 - Openings.

3.3 VALVE APPLICATIONS

A. Install valves at locations indicated on Drawings in accordance with this Section.

B. Install full size ball valves and unions at connections to all equipment.

C. Install full size ball valves at all risers, at branches to all toilet rooms and to isolate sections of the piping system.

D. Install valves with clearance for installation of insulation and allowing access.

E. Install check valves on discharge of water pumps.

F. Install balance valves at the remote part of the domestic hot water return system and where shown on the drawings. Valve size shall be minimum of 3/4-inch.

3.4 INSTALLATION – PRESS STYLE FITTINGS

A. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) recommended by the manufacturer. Contractor shall be trained on the use and installation of the system by manufacturer's representative.

END OF SECTION

SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Formed steel channel
5. Roof supports for piping and equipment.

B. Related Sections:
1. Division 03- Concrete Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 22 04 00 – General Conditions for Plumbing Trades
3. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment:
4. Section 22 10 05 - Plumbing Piping

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.1 - Power Piping.
2. ASME B31.9 - Building Services Piping.

B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

C. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 SUBMITTALS

A. Division 01 - General Requirements

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data: Submit manufacturers catalog data including load capacity.

D. Manufacturer's Installation Instructions: Submit special procedures and assembly of components.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years of experience.

B. Installer: Company specializing in performing Work of this section with minimum 3 years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Division 01- General Requirements.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
1. Globe Pipe Hanger Products Inc.
2. Anvil International
3. Empire Industries
4. Hilti Inc.

B. General:
1. Pipe hangers, supports and accessories shall be metal or copper construction.
2. Materials in contact with piping shall be compatible with piping material.

C. Plumbing Piping - DWV:
1. Conform to ASME B31.9, ASTM F708, or MSS SP 58.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels or formed steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.

8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

D. Plumbing Piping - Water:
1. Conform to ASME B31.9, ASTM F708, or MSS SP 58.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated, Carbon-steel ring.

E. Natural Gas:
1. Conform to MSS SP 58.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe 3 inches and Smaller: Cast iron hook.
6. Vertical Support: Steel riser clamp.
7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.2 HANGER RODS AND HARDWARE

A. Mild steel threaded both ends or continuous threaded unless noted otherwise; with carbon steel hardware.

B. Hangers for Piping at Exterior of the Building: Galvanized steel or stainless steel; threaded both ends or continuous threaded with galvanized steel or stainless steel hardware.

2.3 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division
4. Unistrut Corp.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

C. Supports for Piping at Exterior of the Building: Galvanized steel or stainless steel with galvanized steel or stainless steel hardware..

2.4 ROOF SUPPORTS FOR PIPING

A. Roof supports shall be MAPA Model MB Series products, Miro or approved equal. Provide stainless steel pads to be anchored to the roof structure.

B. Support structure shall be galvanized steel or aluminum and shall be adjustable. Provide with stainless steel threaded rods, stainless steel hardware.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 - General Requirements.

B. Verify openings are ready to receive sleeves.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing and damming materials to arrest liquid material leakage.]

D. Obtain permission from Architect/Engineer before using powder-actuated anchors.

E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut [above] [flush with top of] [recessed into and grouted flush with] slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1, ASME B31.5, ASME 31.9, ASTM F708, or MSS SP 58.

B. Support horizontal piping as scheduled.

C. All pipe hangers and supports shall be sized in accordance with the manufacturer's guidelines to support the piping based on final layout coordinated by the contractor.

D. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

E. Place hangers within 12 inches of each horizontal elbow.

F. Use hangers with 1-1/2 inch minimum vertical adjustment.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for copper piping.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat exposed steel hangers and supports. [Refer to Section 09 90 00.] Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.

N. Provide supplemental angles, channels and formed steel supports to support piping, ductwork, equipment, etc. from building's structure. Piping, equipment, etc. shall not be supported from the roof deck.

3.5 SCHEDULES

PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
Brass	6	1/2
Cast Iron (All Sizes)	5	5/8
Cast Iron (All Sizes) with 10 foot length of pipe	10	5/8
CPVC, 1 inch and smaller	3	1/2
CPVC, 1-1/4 inches and larger	4	1/2
Copper Tube and Pipe, 1-1/4 inches and smaller	6	3/8
Copper Tube and Pipe, 1-1/2 inches and larger	9	1/2
PVC 1 1/2 inch and smaller	3	3/8
PVC 2 inch and larger	4	3/8
Steel, 1-1/2 inches and smaller	7	3/8
Steel, 2 inches to 3 inches	10	1/2
Steel, 4 inches and larger	12	5/8

END OF SECTION

SECTION 220548

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Intent
1. All plumbing equipment and piping as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
3. It is the intent of the seismic portion of this specification to keep all plumbing components in place during a seismic event.
4. All such systems must be installed in strict accordance with seismic codes, component manufacturer's recommendations and building construction standards. Whenever a conflict occurs between the manufacturer's recommendations or construction standards, the most stringent shall apply.
5. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

B. The work of this section includes but is not limited to the following:
1. Vibration isolation elements.
2. Equipment isolation bases.
3. Piping flexible connections.
4. Seismic restraints for isolated and non-isolated plumbing.
5. Certification of seismic restraint designs and installation supervision.
6. Certification of seismic attachment of housekeeping pads.
7. Wind restraints as defined by ASCE Chapter 7 – 2010.

1.2 QUALIFICATIONS

A. Qualifications: Only firms having five years experience designing and manufacturing seismic devices shall be capable of work in this specification.

1.3 DEFINITIONS

A. Life Safety Systems:
1. All systems involved with and/or connected to emergency power supply.
2. All medical and life support systems.

B. Positive Attachment:
1. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping or any other equipment are not acceptable on this project as seismic anchor points.

C. Transverse Bracing:
   1. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe

D. Longitudinal Bracing:
   1. Restraint(s) applied to limit motion parallel to the centerline of the pipe.

E. Failure
   1. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" (3mm) and/or horizontal permanent deformation greater that 1/4" (6mm).

1.4 SUBMITTALS

A. Submit under provisions of Division 1 and Section 22 04 00.

B. The submittal material shall include copies of descriptive data for all products and materials including but not limited to the following:
   1. Descriptive Data:
      a. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
      b. An itemized list showing the items to be isolated and/or seismically restrained, product type or model number to be used and loading and deflection data.
   2. Shop Drawings:
      a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
      b. Provide Drawings showing methods of suspension and support guides for piping and ceiling hung equipment.
      c. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
      d. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
      e. Drawings showing methods for isolation of pipes penetrating walls and floor slabs.
      f. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and/or pipe locations.
   3. Seismic and Wind Certification and Analysis:
      a. Seismic restraint and wind restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
      b. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear

loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45 degrees to the weakest mode.

c. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.06 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall have the following responsibilities:
1. Determine vibration isolation and seismic restraint sizes and locations per specifications.
2. Provide and install isolation systems and seismic restraints as scheduled or specified.
3. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.6 RELATED WORK

A. Housekeeping Pads
1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel
1. Contractor shall supply supplementary support steel for all equipment and piping. including roof mounted equipment, as required or specified.

C. Attachments
1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.7 SEISMIC FORCE LEVELS

A. Installations shall be designed to safely accept external forces determined in accordance with the International Building Code in any direction for all rigidly supported equipment without failure and permanent displacement of the equipment. Seismic restraints shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.

B. Systems listed below to be installed with seismic restraints shall be designed and installed with seismic restraints even if exempt from building codes and ASCE. Design criteria shall be in accordance with the International Building Code and ASCE 7, Chapter 13.

1.8 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 and Section 22 04 00.

B. Record actual locations and installation of vibration isolators and seismic restraints including attachment points.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Mason Industries Inc. models listed below.

B. Other approved manufacturers providing equivalent products include:
1. Novia Associates. (Seismic Control Products)
2. Vibration Eliminator Co.
3. Pate.

2.2 PRODUCT DESCRIPTIONS

A. Vibration Isolators and Seismic Restraint Specifications
1. Specification 1 - Neoprene Pad
a. Two layers of 3/4" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required.
b. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
2. Specification 2 - Bridge - Bearing Neoprene Mountings
a. Bridge bearing neoprene mountings shall have a minimum static deflection of 0.2" and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge bearing specifications. Mountings shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
b. Mountings shall be Type BR as manufactured by Mason Industries, Inc.
3. Specification 3 – Bushing Assemblies
a. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not

interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality.

b. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.

4. Specification 4 - Neoprene Bushing
   a. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact.
   b. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
5. Specification 5 – Spring Isolators
   a. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.
   b. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
6. Specification 6 – Restrained Spring Mountings
   a. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Preapproval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings.
   b. Mountings shall be SLR as manufactured by Mason Industries, Inc.
7. Specification 7 – Spring Mountings
   a. Spring mountings as in specification 5 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4" travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Preapproval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
   b. Mountings shall be SSLFH as manufactured by Mason Industries, Inc.
8. Specification 8 – Air Springs
   a. Air springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either

the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8" Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician.

b. Air Springs shall be Type MT and leveling valves Type LV as manufactured by Mason Industries, Inc.

9. Specification 9 – Restrained Air Springs
   a. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces.
   b. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc.
10. Specification 10 – Hangers
   a. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30^{o} arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30^{o} capability.
   b. Hangers shall be type 30N as manufactured by Mason Industries, Inc.
11. Specification 11 – Hangers
   a. Hangers shall be as described in 10, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic up-stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30^{o} capability.
   b. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
12. Specification 12 - Seismic Cable Restraints
   a. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all directional restraint. Cables must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings.
   b. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to

a beam all as manufactured by Mason Industries, Inc.

13. Specification 13 – Seismic Solid Braces
    a. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "R" number from OSHPD in the state of California verifying the maximum certified load ratings.
    b. Solid seismic brace assemblies shall be type SSB as manufactured by Mason Industries, Inc.
14. Specification 14 – Rod Clamp Assemblies
    a. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.
    b. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
15. Specification 15 – Clevis Hanger Cross Brace
    a. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.
    b. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
16. Specification 16 - All Directional Seismic Snubbers
    a. All directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" (6mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm^2). A minimum air gap of 1/8" (3mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
    b. Snubber shall be Type Z-1225 as manufactured by Mason Industries, Inc.
17. Specification 17 – Equipment Bases
    a. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split case pump shall include supports for suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1".

b. Bases shall be type WF as manufactured by Mason Industries, Inc.

18. Specification 18 – Inertia Foundations
    a. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6". The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1 1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.
    b. Base shall be type BMK or K as manufactured by Mason Industries, Inc.
19. Specification 19 – Flexible Stainless Steel Hoses
    a. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

Flanged		Male Nipples	
3 x 14	10 x 26	1/2 x 9	1 1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2 1/2 x 18
6 x 20	16 x 32	1 1/4 x 12	
8 x 22			

    b. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.
    c. Hoses shall be type BSS as manufactured by Mason Industries, Inc.
20. Specification 20 - All-Directional Acoustical Pipe Anchor
    a. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
    b. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.
21. Specification 21 - Horizontal Thrust Restraint
    a. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to the equipment. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit.
    b. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc.

22. Specification 22 – Pipe Expansion Joints at Building Expansion Joints
    a. Flexible Type 304 stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples.
    b. Hoses shall be type 60 degree VEE as manufactured by Mason Industries, Inc.
23. Specification 23– Seismic Curbs
    a. Curbs shall provide continuous support for the equipment and shall be designed to resist wind and seismic forces. Construction shall be minimum 12 gauge galvanized steel. Provide support angles and cross braces for acoustical panels which shall be installed throughout the entire roof curb. All piping penetrations in the panels shall be sealed with a non hardening caulk. All curbs shall be custom, pitched curbs; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise. Curb shall be Pate PC-4.
24. Specification 24 – Seismic Roof Rails Supporting Equipment and Piping
    a. Supports shall be Novia Model FRR.
    b. Equipment Supports: Spring isolation type.
    c. Piping: Spring isolation type within 50’ of equipment connections and non-isolated at distance of 50’ away from equipment connections
    d. Rails shall bear directly on the roof structure and are flashed and waterproofed into the roof's membrane waterproofing system. Field fabricated rails with external isolators shall not be used. Metal flashing that must be rigidly attached to the floating and non-floating portions of the rail which would short circuit the isolation effectiveness are not acceptable. Waterproofing shall be achieved by use of a continuous flexible water seal attached to the bottom counter flashing. The seal shall be protected from exposure to the elements by the top flashing. All rails shall be custom, pitched rails; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise.
    e. Rails shall include the following features:
        1) Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4-inch thick.
        2) Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces.
        3) Top rail to be formed of 14-gauge minimum G60 galvanized steel with a minimum of two nested layers (or equivalent thickness).
        4) Rails shall be self-supporting without the use of cross bracing.

PART 3 EXECUTION

3.1 GENERAL

A. Vibration isolators and seismic restraint systems shall control excessive noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping. The installation of all vibration isolators and seismic restraint units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.

B. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

C. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment or piping resulting in stresses or misalignment.

D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

E. The contractor shall not install any equipment or piping that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

F. Coordinate work with other trades to avoid rigid contact with the building.

G. Restraints and isolators installed outside or other locations exposed to weather shall be constructed of weather proof materials including galvanized steel structural frames, stainless steel threaded rods, stainless steel hardware, etc

H. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

I. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.

J. At locations where specification 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with specification 14 braces.

K. At all locations where specification 12 or 13 restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with specification type 15 braces.

L. Provide resiliently mounted equipment and piping with seismic snubbers. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Other snubbers shall have clearance between 0.15 inch and 0.25 inch.

3.2 VIBRATION ISOLATION AND SEISMIC RESTRAINT INSTALLATION

A. Seismic /Building Expansion Joints: Install swing joints and/or specification 25 at all locations where piping crosses seismic / building expansion joints. Refer to architectural drawings for locations. Brace piping either side of the expansion joint.

B. Vibration Isolation of Horizontal Piping: The first 50’ of piping connected to plumbing equipment, air compressors or other motorized rotary equipment shall be isolated by hangers as described in specification 10 or 11. Brace hanger rods with SRC clamps specification 14. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment.

C. Vibration Isolation of Plumbing Equipment such as converters, pressure reducing stations, dryers, strainers, storage tanks, condensate receiver tanks, and expansion tanks, which are connected to isolated piping systems, shall be vibration-isolated from the building structure by Mason Industries Type WSW or Type HD isolators (selected for 0.1" static deflection), unless their position in the piping system requires a higher degree of isolation as called for by the piping isolation requirements.

D. Seismic Restraint of Piping
1. Seismically restrain all piping listed below. Use specification 12 cables if isolated. Specification 12 or 13 restraints may be used on unisolated piping.
   a. Natural gas and medical gas piping that is 1" I.D. or larger.
   b. Piping located in boiler rooms and mechanical equipment rooms that is 1 1/4" I.D. and larger.
   c. All other piping 2 1/2" diameter and larger.
2. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Gas piping transverse restraints must be at 20' maximum and longitudinal restraints at 40' maximum spacing.

E. Concrete Inertia Bases
1. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".
2. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
3. The isolators shall be installed without raising the machine and frame assembly.
4. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
5. Install equipment with flexibility in wiring connection.
6. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".
7. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators, or seismic restraints.

F. Vibration Isolation, Seismic Restraint and Anchoring of Plumbing Equipment and Accessories
1. All plumbing equipment and accessories shall be vibration isolated.
2. All plumbing equipment and accessories shall be seismically anchored.
3. All floor mounted equipment shall be installed on housekeeping pads. Equipment shall be anchored to pads to meet acceleration criteria. Concrete pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
4. Base mounted/floor mounted pumps, air compressors and medical gas equipment shall be installed on concrete inertia bases; Specification 20.
5. Pumps: All piping connections to pumps shall be made with specification 22.
6. All plumbing equipment suspended from the building's structure shall be vibration isolated and seismically restrained with combinations of Specification 5 thru 17.

7. Roof mounted equipment and piping shall be seismically anchored and wind restrained with specification 23 and 24.

3.3 INSPECTION

A. Examine systems under provisions of Division 1.

B. On completion of installation of all vibration isolation and seismic devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 220700

PLUMBING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Plumbing piping insulation, jackets and accessories.
2. Plumbing equipment insulation, jackets and accessories.

B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 00 – Common Work Results for Plumbing.
3. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
4. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
5. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
6. Section 22 01 50 – Plumbing Piping
7. Section 22 23 00 - Plumbing Specialties (Coordination of installation of electric heat trace)

1.2 REFERENCES

A. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
13. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
14. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

15. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
16. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
17. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
18. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
19. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
20. IECC 2012 – Insulation Thickness.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 450 50 in accordance with ASTM E84.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Maintain one copy copies of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
1. CertainTeed.
2. Knauf.
3. Johns Manville.
4. Owens-Corning.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
1. Aeroflex. Aerocell.
2. Armacell, LLC. Armaflex.
3. Nomaco. K-flex.

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:
   1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
   2. Thickness: 15 mil.
   3. Connections: Brush on welding adhesive Tacks Pressure sensitive color matching vinyl tape.

C. Aluminum Pipe Jacket:
   1. ASTM B209.
   2. Thickness: 0.020 inch thick sheet.
   3. Finish: Smooth.
   4. Joining: Longitudinal slip joints and 2 inch laps.
   5. Fittings: Minimum 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: Minimum 3/8 inch wide; 0.02inch thick aluminum.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum stainless steel jacket single piece construction with self adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
   1. Thermal Conductivity: 0.24 at 75 degrees F.
   2. Operating Temperature Range: 0 to 450 degrees F.
   3. Density: 1.65 pound per cubic foot.

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied kraft reinforced aluminum foil jacket.
   1. Thermal Conductivity: 0.24 at 75 degrees F.
   2. Operating Temperature Range: 0 to 450 degrees F.
   3. Density: 3.0 pound per cubic foot.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F.

C. TYPE E-3: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:
   1. Product Description: ASTM D1785, sheet material, off-white color.
   2. Minimum Service Temperature: -40 degrees F.
   3. Maximum Service Temperature: 150 degrees F.
   4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
   5. Thickness: 20 mil.
   6. Connections: Brush on welding adhesive Tacks Pressure sensitive color matching vinyl tape.

B. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

C. Vapor Retarder Jacket:
   1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

D. Field Applied Glass Fiber Fabric Jacket System:
   1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
   2. Glass Fiber Fabric:
      a. Cloth: Untreated; 9 oz/sq yd weight.
      b. Blanket: 1.0 lb/cu ft density.
      c. Weave: 10 x 10.
   3. Indoor Vapor Retarder Finish:
      a. Cloth: Untreated; 9 oz/sq yd weight.
      b. Vinyl emulsion type acrylic, compatible with insulation, black white color.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify piping and equipment has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Hot Piping Systems less than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

F. Hot Piping Systems greater than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

G. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
    a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.

b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

H. Insulation Terminating Points:
1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

I. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

J. High Temperature Pipe Insulation:
1. Install in multiple layers to meet thickness scheduled.
2. Attach each layer with bands. Secure first layer with bands before installing next layer.
3. Stagger joints between layers.
4. Finish with canvas jacket sized for finish painting.
5. Cover with aluminum jacket stainless steel jacket with seams located on bottom side of horizontal piping.

K. Piping and Fittings Exposed in Mechanical Rooms (less than 10 feet above finished floor): Finish with PVC jacket.

L. Piping and Fittings Exposed in Occupied Spaces (less than 10 feet above finished floor): Finish with aluminum jacket.

M. Piping and Fittings Exposed in Occupied Spaces including ceiling spaces (over 10 feet above finished floor): Finish with PVC jacket.

N. Heat Traced Piping: Confirm heat trace wiring and accessories are complete prior to installation.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.

2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140 degrees F:
1. Insulate flanges and unions with removable sections and jackets.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

G. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

3.4 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Domestic and Non Potable Hot Water Supply and Recirculation	P-1	Up to and including 1-1/4”	1.0
Domestic and Non Potable Hot Water Supply and Recirculation	P-1	1-1/2” and larger	1.5
Non Potable Hot Water Supply Installed with Electric Heat Trace	P-1	All sizes	2.0
Domestic and Non Potable Cold Water	P-1 or P-2	Up to and including 1-1/4”	0.5
Domestic and Non Potable Cold Water	P-1 or P-2	1-1/2” and larger	1.0
Trap Primer Piping (above ground and buried)	P-2	All sizes	0.5

B. Drainage Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Storm Piping (within the building): Horizontal runs only	P-1 or P-2	All sizes	1.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Roof Drain Bodies	E-2 or E-3	1.0

END OF SECTION

SECTION 221005

PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.
1. Sanitary sewer.
2. Domestic water and non-potable water.
3. Storm water.
4. Equipment drains, pressure relief and over flows.
5. Flanges, unions, and couplings.

B. Related Sections
1. Division 01 – General Requirements.
2. Division 09 - Finishes.
3. Section 22 0400 – General Conditions for Plumbing Trades.
4. Section 22 0500 –Common Work Results for Plumbing.
5. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.
6. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
7. Section 22 0700 - Plumbing Insulation.
8. Division 26 – Electrical: Electrical characteristics and wiring connections.
9. Division 31 - Earthwork
10. Division 33 - Utilities.

1.2 REFERENCE STANDARDS – Most Currently adopted versions and amendments for the location of the project.

A. American Society of Mechanical Engineers
1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
3. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250.
4. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
6. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
7. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
8. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
9. ASME B31.9 - Building Services Piping.
10. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers.
11. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications.

B. American Society of Sanitary Engineering
1. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems.

C. American Society for Testing and Materials

1. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
4. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
6. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
7. ASTM B32 - Standard Specification for Solder Metal.
8. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
9. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
10. ASTM B68 - Standard Specification for Seamless Copper Tube, Bright Annealed.
11. ASTM B75 - Standard Specification for Seamless Copper Tube.
12. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
13. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes.
14. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
15. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
16. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
17. ASTM C1053 - Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
18. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
19. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
20. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
21. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
22. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
23. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
24. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
25. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
26. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
27. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
28. ASTM D2846 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
29. ASTM D2855 - Standard Practice for the Two-Step (Primer & Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
30. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

31. ASTM F437 - Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
32. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
33. ASTM F439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
34. ASTM F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
35. ASTM F442 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
36. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
37. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
38. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
39. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. American Welding Society
1. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
2. AWS D1.1 - Structural Welding Code - Steel;.

E. American Water Works Association
1. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
2. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
3. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
5. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.
6. AWWA C606 - Grooved and Shouldered Joints.
7. AWWA C651 - Disinfecting Water Mains.
8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Transmission and Distribution; 2016.
9. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service.

F. Cast Iron Soil Pipe Institute
1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

G. International Code Council
1. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Element.
2. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
3. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.
4. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

H. National Sanitation Foundation
   1. NSF 61 - Drinking Water System Components - Health Effects.
   2. NSF 372 - Drinking Water System Components - Lead Content.

I. Plastic Pipe Institute
   1. PPI TR-4 - PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe.

1.3 SUBMITTALS

A. See Division 01- General Requirements

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Welder Certificate: Include welder’s certification of compliance with ASME BPVC-IX.

D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.

E. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.

F. Project Record Documents: Record actual locations of valves.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Division 01 -General Requirements.
   2. Valve Repacking Kits: One for each type and size of valve.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.6 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.2 SANITARY SEWER PIPING

A. PVC Pipe: ASTM D2665, Schedule 40.
   1. Fittings: PVC; ASTM D2665, Schedule 40.
   2. Joints: Solvent welded, ASTM D2564 solvent cement.

2.3 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Pipe: ASTM B42, hard drawn; Type K.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
   2. Joints: ASTM B32, alloy Sn95 solder.
   3. Joints: AWS A5.8M/A5.8, BCuP copper/silver braze.

B. Ductile Iron Pipe: AWWA C151/A21.51.
   1. Fittings: Ductile or gray iron, standard thickness.
   2. Joints: AWWA C111/A21.11, rubber gasket with 3/4 inch (19 mm) diameter rods.

2.4 WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88, Type L.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, alloy Sn95 solder.
   3. Press Fit Joints: ASME B16.22 wrought copper with EPDM sealing element and press end type, fitting bead collars: 2 ½” to 4” sizes shall include stainless steel grip ring. Joints: Mechanically connected with crimping tool. Fittings and accessories shall be Viega Pro-Press, Milwaukee, Mueller or Nibco Joints. Manufacturer of press fit joints shall be same manufacturer as other press fit valves and accessories.

2.5 EQUIPMENT DRAINS, PRESSURE RELIEF AND OVERLFOW PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88, Type L.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, alloy Sn95 solder.

3. Press Fit Joints: ASME B16.22 wrought copper with EPDM sealing element and press end type, fitting bead collars: 2 ½" to 4" sizes shall include stainless steel grip ring. Joints: Mechanically connected with crimping tool. Fittings and accessories shall be Viega Pro-Press, Mueller or Nibco Joints:

2.6 STORM WATER PIPING

A. PVC Pipe: ASTM D2665, Schedule 40.
   1. Fittings: PVC; ASTM D2665, Schedule 40.
   2. Joints: Solvent welded, ASTM D2564 solvent cement.

2.7 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under: Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 3 Inch: Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Union or other dielectric fitting with water impervious isolation barrier.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

C. Install piping to maintain headroom, conserve space, and not interfere with use of space.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.

E. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0700.

F. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Division 08 Openings.

G. Establish elevations of buried piping outside the building to ensure not less than the local area's frost depth of cover.

H. Install vent piping penetrating roofed areas to maintain integrity of roof assembly and a minimum of 25 feet from an air intake.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Provide support for utility meters in accordance with requirements of utility companies.

K. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
   1. Painting of interior plumbing systems and components are specified in Division 09 - Finishes.
   2. Painting of exterior plumbing systems and components are specified in Division 09 - Finishes.

L. Install bell and spigot pipe with bell end upstream.

M. Install water piping to ASME B31.9.

N. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

O. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2564.

P. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

Q. Provide non-conducting dielectric connections wherever jointing dissimilar metals. Materials which do not need dielectric connections are:
   1. Cast iron to copper pipe connections.
   2. Cast iron to brass or bronze pipe connections.
   3. Brass or bronze to copper pipe connections.

3.4 INSTALLATION – PRESS STYLE FITTINGS

A. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) recommended by the manufacturer. Contractor shall be trained on the use and installation of the system by manufacturer's representative.

B. Pressure test to identify un-pressed fittings: Utilizing air or water, the system shall be pressurized, not to exceed 85 psi. If there is a significant drop in pressure, the system shall be walked to check for un-pressed fittings. Should an un-pressed fitting be located,

the pressure should be released from the system and the un-pressed fitting shall be pressed. If no un-pressed fitting is identified the system shall be pressurized to test pressures required by code, not to exceed 600 psi.

3.5 TOLERANCES

A. Sanitary Drainage Piping (except Massachusetts): slope to sanitary drain at minimum of 1/8 inch per foot.

B. Sanitary Drainage Piping (in Massachusetts): slope to sanitary drain at minimum of 1/4” per foot for horizontal piping 3” and smaller. Slope sanitary drain 1/8” per foot for horizontal piping larger than 3 inches.

3.6 SYSTEM FLUSHING

A. The following system flushing criteria shall apply to all domestic water piping systems inclusive of hot water, cold water and hot water recirculation.

B. Upon completion of installation of piping, and prior to disinfection, flush the piping systems with clean, potable water until dirty water does not appear at the points of outlet.

C. Remove strainers and flow restrictors from fixtures prior to flushing and reinstall after flushing is complete

D. Mixing valves located at fixtures shall not be installed until after flushing is complete. Provide temporary bypass connections as required.

E. Provide isolation and temporary bypass piping for water heaters, expansion tanks, and other equipment.

F. Run fixtures simultaneously for a minimum of 30 minutes or until no debris is evident.

G. Flushing shall be considered satisfactory when no debris is evident after running water through a number 80 mesh screen.

H. Contractor to notify engineer and owner a minimum of 72 hours before performing flushing.

I. Once system has been successfully flushed, contractor shall provide a report to engineer documenting flushing procedure and results.

3.7 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.8 TESTING

A. All piping systems installed under this Contract shall be pressure tested with clean, clear water to insure tightness.

B. Contractor shall be responsible for furnishing all plugs, piping, valves, hoses, and pumps necessary for required tests and for proper disposal of the water upon completion of the tests. All lines shall be thoroughly cleaned before testing.

C. Items which are not to be subjected to the hydrostatic test shall be either removed or blanked off. Short sections of piping which must be removed to permit the installation of blinds or blanks must be tested separately.

D. The test pump hook-up for hydrostatic test shall be such that the pressure may be applied gradually under perfect control. A valve shall be provided for blocking in the piping during the test period. The systems should be filled with water thru a low connection point, care being taken that air is completely vented so that there are no air pockets remain. The pressure shall be applied gradually and held at the specified value for the time required to visually check each weld, connection, joint, flange, etc., but not less than a minimum of two hours. Test readings may be taken at the lowest point of the line or system of lines providing static head is added to the minimum hydrostatic test pressure. Care shall be taken to insure that at no point a dangerous over-pressure is experienced.

E. The hydrostatic test shall be considered satisfactory if no visible leakage, cracks or other signs of distress are discovered on the piping or at any joints. There is no requirement for minimum pressure drop during the test period; however, the cause of any pressure loss other than that due to temperature change or similar reasons shall be justified to the satisfaction of the Owner’s representative.

F. Minor leaks in screwed or flanged joints may be repaired without retesting subject to the approval of the Owner.

G. After completion of the hydrostatic testing, the system shall be completely drained at all low points. All test blinds, temporary supports, test equipment, etc., shall then be removed, and any valves, orifice plates, short sections of piping, miscellaneous in-line equipment or instruments that were left ready for service. New gaskets shall be used when re-installing flanged items.

H. If there is any danger of contamination or freezing, blow out the piping system with dry, oil-free air as necessary.

I. At completion of tests Contractor shall submit a typewritten log of test data for Owner's permanent file including:
   1. Data of test.
   2. Section tested-attach sketch.
   3. Equipment used.
   4. Personnel involved.
   5. Owner or Owner's witness in attendance.
   6. Results.

J. After repair any failed test shall be repeated until all requirements of this Section are me.

K. Test Pressures:
   1. All piping systems unless notes otherwise shall be tested at 100 psig or 1.5 times the operating pressure, whichever is greater.
   2. Drain piping shall be tested at 10 ft head.

3.9 SERVICE CONNECTIONS

A. Provide new storm and sanitary sewer services. Before commencing work check invert elevations required for storm and sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve and strainer.
   1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Anchor service main inside to floor and adjacent wall.

END OF SECTION

SECTION 221123

FUEL GAS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Natural gas systems.
2. Piping buried beyond 5 feet of building.
3. Piping buried within 5 feet of building.
4. Piping above grade.
5. Unions and flanges.
6. Valves.
7. Strainers.
8. Natural gas pressure regulators.
9. Natural gas pressure relief valves.
10. Underground pipe markers.
11. Bedding and cover materials.

B. Related Sections:
1. Division 05- Metals
2. Division 09- Finishes
3. Section 22 0400 – General Conditions for Plumbing Trades
4. Section 22 0500 – Common Work Results for Plumbing Trades
5. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
6. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
7. Section 22 34 00 – Fuel-Fired Domestic Water Heaters.
8. Division 23 – Fuel-Fired Equipment.
9. Division 31 - Earthwork
10. Division 33 - Utilities

1.2 REFERENCES – Most Currently adopted versions and amendments for the location of the project.

A. American National Standards Institute:
1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

B. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
4. ASME B31.9 - Building Services Piping.
5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. ASTM International:
1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

E. American Water Works Association:
1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
3. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

G. National Fire Protection Association and International Codes:
1. NFPA 54 - National Fuel Gas Code.

H. Underwriters Laboratories Inc.:
1. UL 842 - Valves for Flammable Fluids.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.

C. Provide pipe hangers and supports in accordance with ASME B31.9, ASTM F708, and MSS SP 58.

D. Use plug valves or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.4 SUBMITTALS

A. Division 01 – General Requirements

B. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.

4. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
   a. Strainers.
   b. Natural gas meters
   c. Natural gas pressure regulators.
   d. Natural gas pressure relief valves.

C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Test Reports: Indicate results of piping system pressure test.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 CLOSEOUT SUBMITTALS

A. Division 01 - General Requirements.

B. Project Record Documents: Record actual locations of valves piping system, and system components.

C. Operation and Maintenance Data: Submit for valves, gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.

1.6 QUALITY ASSURANCE

A. Perform gas Work in accordance with NFPA 54.

B. Perform Work in accordance with applicable code and local gas company requirements.

C. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

D. Perform Work in accordance with applicable codes and authority having jurisdiction, AWS D1.1 for welding hanger and support attachments to building structure.

E. Perform work in accordance with Owner’s insurance company’s requirement.

F. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

C. Design piping system, hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed in the State of the Project location.

1.8 PRE-INSTALLATION MEETINGS

A. Division 01 - General Requirements

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - General Requirements

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - General Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 COORDINATION

A. Division 01 - General Requirements

B. Coordinate trenching, excavating, bedding and backfilling of buried piping systems with requirements of Division 31 - Earthwork.

1.13 WARRANTY

A. Division 01 - General Requirements

1.14 EXTRA MATERIALS

A. Division 01 - General Requirements

B. Furnish two packing kits for each type and size valve.

PART 2 PRODUCTS

2.1 FUEL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Steel Pipe: ASTM A53 Schedule 40 black.
   1. Fittings: ASTM A234, wrought steel welding type.
   2. Joints: ASME B31.1, welded.
   3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.2 FUEL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53 Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234, wrought steel welding type.
   2. Joints: Threaded or welded to ASME B31.1.
   3. At Exterior of Building: Provide AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.3 FUEL GAS REGULATOR VENT PIPING, ABOVE GRADE

A. Same as Fuel Gas Piping, Above Grade.

2.4 FUEL GAS PIPING, EQUIPMENT CONNECTIONS

A. Steel Pipe: ASTM A53 Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
   2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

B. Corrugated Stainless Steel Tubing (Pipes Sizes 1” and less): ANSI LC 1.

2.5 UNIONS AND FLANGES

A. Pipe 2 inches and Smaller:
   1. Ferrous Piping: Class 150, malleable iron, threaded.
   2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Pipe 2-1/2 inches and Larger:
   1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
   2. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.6 BALL VALVES

A. Manufacturers:
   1. Crane Valve, North America
   2. Hammond Valve
   3. Milwaukee Valve Company
   4. NIBCO, Inc.
   5. Stockham Valves & Fittings
   6. Watts

B. 1/4 inch to 1 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and fuel gases, full port.

C. 1-1/4 inch to 3 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and fuel gases, conventional port.

2.7 PLUG VALVES

A. Manufacturers:
1. DeZURIK, Unit of SPX Corp.
2. Flow Control Equipment, Inc.
3. Homestead Valve

B. 2 inches and Smaller: MSS SP 78, Class 150 semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.

C. 2-1/2 inches and Larger: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, flanged ends. Furnish wrench-operated up to 4” and worm gear-operated over 4”.

2.8 PIPE HANGERS AND SUPPORTS

A. Refer to Section 22 0529 – Hangers and Supports for Plumbing Piping and Equipment

B. Refer to schedule in this section for spacing and dimensional requirements.

2.9 STRAINERS

A. Manufacturers:
1. Mueller Steam Specialty
2. Armstrong
3. Spirax Sarco, Inc.
4. Yarway
5. Substitutions: Division 01 - General Requirements.

B. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. 5 inch and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.10 NATURAL GAS PRESSURE REGULATORS

A. Manufacturers:
1. Invensys
2. Maxitrol
3. Dormont

B. Product Description: Spring loaded, general purpose, self-operating service regulator. Provide with internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
1. Comply with ANSI Z21.80.
2. Temperatures: minus 20 degrees F to 150 degrees F.
3. Body: Steel.
4. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.

5. Disk, diaphragm, and O-ring: Nitrile
6. Maximum inlet pressure: 150 psig.
7. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

2.11 NATURAL GAS PRESSURE REGULATORS (NON-VENTED)

A. Manufacturers:
1. Invensys
2. Maxitrol
3. Eaton Corporation; Controls Div.
4. Fisher Control Valves and Regulators.
5. Harper Wyman Co.

B. Product Description: Spring loaded, general purpose, self-operating service regulator. Provide with follow features:
1. Comply with ANSI Z21.80/CSA 6.22
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Provide with factory installed vent limiter complying with ANSI Z21.80/CSA 6.22. Regulator shall be suitable for indoor installation without the need of vent piping to the outdoors.
12. Suitable for outdoor use to minus 40 F ambient temperature

2.12 NATURAL GAS PRESSURE RELIEF VALVES

A. Manufacturers:
1. Dresser
2. Fisher
3. Maxitrol

B. Product Description: Spring loaded type relief valve.
1. Body: Aluminum.
2. Diaphragm: Nitrile
3. Orifice: Stainless steel.
4. Maximum operating temperature: 150 degrees F.
5. Inlet Connections: Threaded.
6. Outlet or Vent Connection: Same size as inlet connection.

2.13 BEDDING AND COVER MATERIALS

A. Bedding: Refer to Division 31 – Earthwork

B. Cover: Refer to Division 31 – Earthwork

C. Soil Backfill from Above Pipe to Finish Grade: Refer to Division 31 – Earthwork

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 – General Requirements

B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION - INSERTS

A. Refer to 22 0500 – Common Work Results for Plumbing Trades.

3.4 INSTALLATION - BURIED PIPING SYSTEMS

A. Install fuel gas piping in accordance with NFPA 54.

B. Verify service size, location, and invert are as indicated on Drawings.

C. Establish elevations of buried piping with not less than 3 ft of cover.

D. Remove scale and dirt on inside of piping before assembly.

E. Route pipe in straight line.

F. Install pipe to allow for expansion and contraction without stressing pipe or joints.

G. Pipe trench excavation, bedding material and backfilling shall be in accordance with Division 31 – Earthwork

H. Install trace wire continuous above pipe line; coordinate with Division 31 - Earthwork

3.5 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Install natural gas piping in accordance with NFPA 54.

B. The contractor shall furnish and install an adequate natural gas supply to all gas fired appliances and devices throughout the project. In addition to the specifications and drawings included in Division 22, the contractor shall also review the contract documents prepared by other trades for coordination and additional work by the plumbing contractor required to complete the project.

C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

D. Route piping in orderly manner and maintain gradient.

E. Where required, bend pipe with pipe bending tools in accordance with procedures intended for that purpose.

F. Install piping to conserve building space and not interfere with use of space.

G. Size and install gas piping to provide sufficient gas to supply maximum appliance demand at pressure higher than appliance minimum inlet pressure.

H. Group piping whenever practical at common elevations.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

J. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 0500.

K. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Division 07 – Thermal and Moisture Protection.

L. Provide clearance for installation of insulation and access to valves and fittings.

M. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08 - Openings.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer. Refer to Division 05 – Metals.

O. Provide support for utility meters in accordance with requirements of utility company.

P. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood. Protect vent against entry of insects and foreign material.
1. Minimum Vent Size: Connection size at regulator vent connection.
2. Run individual vent line from each relief device, independent of breather vents.
3. Provide min. 25 feet separation between vent termination and mechanical air intakes and similar opening.

Q. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Division 09 - Finishes.

R. Install identification on piping systems including underground piping. Refer to Section 22 0500.

S. Install valves with stems upright or horizontal, not inverted.

T. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

U. Install gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Tee fitting shall be 10 pipe diameters upstream of regulator minimum. Cap or plug one opening of tee fitting.

V. Piping installed at the building exterior shall be provided with polyethylene jacket or double layer, polyethylene.

W. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors.

X. Provide gas service complete with gas meter and regulators. Coordinate new service with location gas company

Y. Provide regulators on each piece of equipment and appliances, sized in accordance with equipment manufacturer.

Z. Provide flexible pipe as final connection to roof mounted mechanical equipment when seismic roof curbs are used.

3.6 FIELD QUALITY CONTROL

A. Division 01 – General Requirements.

B. Where gas appliance will be damaged by test pressure, disconnect appliance and cap piping during pressure test. Reconnect appliance after pressure test and leak test connection.

C. Where gas appliance is designed for operating pressures equal to or greater than piping test pressure, provide gas valve to isolate appliance or equipment from gas test pressure.

D. Pressure test fuel gas piping in accordance with NFPA 54.

E. Inspect, test and purge gas piping in accordance with NFPA 54 and local gas company requirements. Where new branch piping is extended from existing system, pressure test new branch piping only. Leak test joint between new and existing piping with noncorrosive leak detection fluid or other approved method.

F. When pressure tests do not meet specified requirements, remove defective work, replace and retest.

G. Immediately after gas is applied to a new system, or a system has been restored after gas service interruption, check pipe for leakage.
   1. Where leakage is detected, shut off gas supply until necessary repairs are complete.

H. Do not place appliances in service until leak testing and repairs are complete.

END OF SECTION

SECTION 222123

PLUMBING PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. In-line circulators.

B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 00 – Common Work Results for Plumbing.
3. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
5. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
6. Section 21 0510 – Plumbing Piping
7. Division 16 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Underwriters Laboratories Inc.:
1. UL 778 - Motor Operated Water Pumps.

1.3 PERFORMANCE REQUIREMENTS

A. Provide pumps to operate at system fluid temperatures indicated on Drawings without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.

C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Division 01 - Warranties and Bonds: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 IN-LINE CIRCULATORS

A. Manufacturers:
1. Taco
2. B+G.
3. Armstrong
4. Grundfos

B. NSF/ANSI 61 & 372 and UL listed.

C. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 175 psig maximum working pressure.

D. Casing: Stainless steel or brass, with flanged pump connections.

E. Impeller: One piece cast stainless steel (304), Stamped brass or cast bronze, keyed to shaft.

F. Bearings: Two, oil lubricated bronze sleeves.

G. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.

H. Seal: Carbon rotating against stationary ceramic seat, 250 degrees F maximum continuous operating temperature.

I. Drive: closed coupling direct driven pump.

J. Electrical Characteristics and Components:
1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes 4 inches and over.

C. Install pumps with vibration isolation. Refer to Section 22 0548.

D. Provide line sized shut-off valve and strainer pump suction fitting on pump suction, and line sized soft seat check valve and shut-off valve on pump discharge.

E. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.

F. Provide air cock and drain connection on horizontal pump casings.

G. Provide drains for bases and seals.

H. Check, align, and certify alignment of base mounted pumps prior to start-up.

I. Lubricate pumps before start-up.

3.2 MANUFACTURER'S FIELD SERVICES

A. Division 01 - Quality Requirements: Requirements for manufacturer's field services.

B. Test and start-up equipment in accordance with manufacturer's start-up instructions.

C. Adjust all parameters in accordance with manufacturer recommendations.

3.3 CLEANING

A. Clean all devices upon completion of Work.

3.4 DEMONSTRATION AND TRAINING

A. Division 01 – Demonstration and Training. Requirements for demonstration and training.

B. Demonstrate operation and maintenance procedures.

C. Furnish services for manufacturer's technical representative for four hours to instruct Owner's personnel in operation and maintenance. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION

SECTION 223000

PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Roof drains.
2. Overflow drains.
3. Combination roof/overflow drains.
4. Downspout nozzles.
5. Floor drains.
6. Floor sinks
7. Area drains.
8. Cleanouts.
9. Hose bibs.
10. Wall hydrants.
11. Water hammer arrestors.
12. Trap primers.
13. Expansion tanks.
14. Recessed valve boxes.
15. Stops.
16. Electric heat trace.

B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 00 – Common Work Results for Plumbing.
3. Section 22 07 00 – Plumbing Insulation.
4. Section 22 11 23 – Facility Natural-Gas Piping.
5. Section 22 21 23 – Plumbing Pumps.
6. Section 22 40 00 – Plumbing Fixtures
7. Division 26 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
2. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
3. ANSI A112.21.1 - Floor Drains.
4. ANSI A112.21.2 - Roof Drains.
5. ANSI A112.26.1 - Water Hammer Arrestors.

B. International Association of Plumbing and Mechanical Officials:
1. IAPMO IGC 187 – Roof Drains with Integral Overflow Drain.

C. Plumbing Drainage institute:
1. PDI WH-201 – Water Hammer Arresters.

D. Safe Drinking Water Act.
1. SDWA 1417 - Standard for Lead Free Drinking Water.

1.3 SUBMITTALS

A. Division 01 - Submittal Procedures.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

C. Product Data: Provide component sizes, rough-in requirements, service sizes, capacities and finishes.

D. Manufacturer's Installation Instructions: Submit installation methods and procedures. Indicate assembly and support requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.5 QUALITY ASSURANCE

A. Record actual locations of equipment, cleanouts, etc.

B. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.

C. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.

D. All plumbing specialties installed on the domestic water distribution system including hose bibs, wall hydrants, meters, valves and stops shall be lead free and shall meet the requirements of SDWA 1417.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Accept specialties on site in factory packaging. Inspect for damage.

C. Protect installed specialties from damage by securing areas.

1.9 WARRANTY

A. Division 01 - Warranties and Bonds: Requirements for warranties.

1.10 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. For Floor Sink FS-1, schedule on the drawings calls for all FS-1 to be provided with ¾ grate. Provide 5 extras full size grates.

C. Provide two loose keys for hose bibs and wall hydrants.

PART 2 PRODUCTS

2.1 MANUFACTURERS FOR DRAINS AND CLEANOUTS

A. Manufacturers:
1. JR Smith.
2. Watts.
3. Josam.
4. Wade.
5. Zurn.
6. Wade.
7. MiFab.

2.2 ROOF DRAINS

A. Roof Drains: ANSI A112.21.2, cast iron body, flashing clamp, cast iron grate.

2.3 OVERFLOW DRAINS

A. Overflow Drains: ANSI A112.21.2, cast iron body, flashing clamp, cast iron grate. Provide with standpipe interior to dome cover and extended to above flood elevation.

2.4 COMBINATION ROOF DRAIN / OVERFLOW DRAINS

A. Cast iron body, flashing clamp, cast iron grate. Provide with standpipe interior to dome cover and extended to above flood elevation. Single fixture shall have two pipe connections.

2.5 DOWNSPOUT NOZZLES

A. Cast Bronze body, wall flange and bird screen.

2.6 FLOOR DRAINS

A. Floor Drains: ANSI A112.21.1, cast iron body, nickel bronze top, flashing collar, adjustable strainer-head, trap primer connection. Provide perforated sediment buckets at

floor drains installed in the boiler room and mechanical rooms. All floor drains installed in the Food Service Areas shall be acid resistant cast iron or stainless steel.

2.7 FLOOR SINKS

A. Floor Sinks: ANSI A112.21.1. Square nickel bronze top, dome bottom strainer, flashing collar, trap primer connection. . Provide perforated sediment buckets at floor drains installed in the boiler room and mechanical rooms. All floor sinks installed in the Food Service Areas shall be acid resistant cast iron or stainless steel.

2.8 TRENCH DRAINS

A. Trench Drains: Extra heavy duty, Class E, sloping trench with enamel coated welded steel frame support and slotted stainless steel grate.

2.9 AREA DRAINS

A. Area Drains: ANSI A112.21.2.

2.10 CLEANOUTS

A. Interior Finished Floor Cleanouts: Cast iron body with adjustable scoriated nickel bronze top and vandal proof screws.

B. Interior Finished Wall Cleanouts: Line type with cast iron body, round epoxy coated gasketed cover and round stainless steel access cover secured with machine screw.

C. Interior Unfinished Accessible Areas: Caulked or threaded type. Provide stack cleanouts on vertical rainwater leaders.

2.11 HOSE BIBS

A. Manufacturers:
1. Woodford.
2. Josam.
3. Wade.
4. Zurn.
5. Watts.

B. ANSI/ASSE 1011 Bronze or brass with integral mounting flange, lead free.

2.12 WALL HYDRANTS

A. Manufacturers:
1. Woodford.
2. Josam.
3. Wade.
4. Zurn.
5. Watts.

B. Wall Hydrant: ANSI/ASSE 1019; self-draining type, lead free, backflow protected, freeze proof with removable key.

2.13 WATER HAMMER ARRESTORS

A. Manufacturers:
1. Woodford.
2. Josam.
3. Wade.
4. Zurn.
5. Watts.

B. ANSI A112.26.1; sized in accordance with PDI, lead free precharged, suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psig working pressure.

2.14 TRAP PRIMERS

A. Manufacturers:
1. Precision.
2. Wade.
3. Zurn.
4. Watts.

B. ASSE 1018: Corrosion resistant brass, pressure operating range 35 to 75 psig, 120 volt – 1 phase power.

2.15 EXPANSION TANKS

A. Manufacturers:
1. Amtrol.
2. Taco.
3. Bell and Gossett.
4. Watts.

B. Construction: Welded steel, ASME labeled, tested and stamped in accordance with Section 8D of ASME Code; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

2.16 RECESSED VALVE BOXES

A. Manufacturers: Symmons model as scheduled on the drawings.

B. Other acceptable manufacturers offer equivalent products:
1. Acorn
2. Josam
3. Potter Roemer

C. Washing Machine: Plastic preformed rough-in box with brass water control valve, socket for 2 inch waste, and cover.

D. Refrigerator: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.17 STOPS

A. Manufacturers:
1. Brass Craft.
2. Watts.
3. Nibco.
4. McGuire.

B. Chrome plated angle brass supply stop valve with full turn brass stem, lead free, inlet shall be 1/2-inch sweat, outlet shall be 3/8-inch compression. Supply stop shall be LFST082LK as manufactured by McGuire or approved equal.

2.18 ELECTRIC HEAT TRACING

A. Manufacturers: BriskHeat Type SL-Cable or approved by Raychem or Heat-Trace.

B. Characteristics:
1. Self limiting, parallel circuit type which automatically self regulates heat output. Cable shall be acceptable for operating temperatures to 250 degrees F. Product shall be Factory Mutual approved or UL listed.
2. Construction: 16 gauge nickel plated copper conductor, self regulating conductive core, thermoplastic elastomer inner jacket, metallic over-braid and thermoplastic outer jacket.
3. Capacity: 5 watts per foot with 120 volt electrical power. Maximum length per circuit shall be 270 feet at 50F with 20 amp circuit breaker.

C. Temperature Controller: BriskHeat Model TD101N controller with SPST switch and preset range of 110 to 140 degrees F. Provide with disconnect switch and Ground Fault Protection unit.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify walls and floor finishes are prepared and ready for installation of fixtures.

C. Verify electric power is available and of correct characteristics.

3.2 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.3 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Cleanouts shall be same size as the pipes served, up to 4 inches; 5 and 6 inch pipes shall have 4 inch cleanouts; 8 inch pipes shall have 6 inch cleanouts; 10 inch pipes and larger shall have 8 inch cleanouts.

D. Cleanouts: Provide at all floor drains and trench drains installed on slab (where pipe trap is below grade). Cleanout shall be within 36” of trap outlet. Exception is for locations where branch piping serving the fixture is less than 48” from trap outlet to piping main.

E. Install components level and plumb.

F. Install water hammer arrestors with isolation valve in accessible locations.

G. Trap primers shall be installed to serve all floor drains, provide distribution units as required for all drains.

H. Trap primer connections shall be installed on cold water piping 1 ½ inch diameter or less.

I. Install hose bib with integral vacuum breaker and with cold water supply in all gang toilet rooms.

3.4 INTERCEPTORS

A. Provide sediment interceptors for all art room sinks, maintain clearances as required by the manufacturer.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop-drawings. Confirm location and size of drains before rough in and installation.

3.6 CLEANING

A. Division 01 - Execution and Closeout Requirements: Final cleaning.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Division 01 - Execution and Closeout Requirements: Protecting installed construction.

END OF SECTION

SECTION 223400

FUEL FIRED DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes fuel fired water heaters and accessories.

B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 00 – Common Work Results for Plumbing.
3. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
5. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
6. Section 21 0510 – Plumbing Piping
7. Division 16 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

A. UL 795 “Commercial – Industrial Gas Heating Equipment”

B. ASME Boiler and Pressure vessel code, section IV.

C. ANSI Z21.10.3/CSA 4.3 “Gas Water Heaters”

D. ASHRAE/IES 90.1

E. ASME CSD-1 “Controls and Safety Devices for Automatically Fired Boilers”

F. NFPA 70- National Electric Code

G. NFPA 54- National Fuel Gas Code

H. NSF/ANSI Standard 61- Drinking Water System Components I. ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.” Underwriters Laboratories Inc.

1.3 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Provide dimension drawings of water heaters indicating components and connections to other equipment and piping. Submit data showing capacity and finishes.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

C. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.6 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Product storage and handling requirements.

B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

A. Division 01 - Warranties and Bonds: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 WATER HEATERS - GENERAL

A. Manufacturers:
1. PVI
2. AO Smith
3. Lochinvar

B. NSF/ANSI 61 & 372 and UL listed.

C. The water heaters shall be ETL listed as a complete unit

2.2 CONSTRUCTION

A. Water heater will be a fire tube, storage-type design firing natural gas.

B. The storage section of the water heater shall be ASME HLW stamped and National Board Registered for a maximum allowable working pressure of 150 psi and pressure tested at 1-1/2 times working pressure.

C. All tank connections/ fittings shall be nonferrous. Tank shall be equipped with a ball-type drain valve. Tank design will include a manway sized access to the tank interior.

D. The storage tank shall be an unlined pressure vessel constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923Methods.

E. Waterside surfaces shall be welded internally utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.

F. The combustion chamber shall be fabricated from duplex stainless steel that is pickle-passivated after complete fabrication. The fire tubes shall be solid copper. The heat exchanger shall be field removable from the pressure vessel, allowing 100% access to waterside surfaces

G. External economizer shall be constructed of 316L stainless steel.

H. Burner shall be stainless steel.

I. Water heater shall be a category IV, condensing appliance. Water heater is equipped for connection to direct inlet combustion air vent.

J. The water heater shall be completely factory packaged on a skid, requiring only job site hookup to utilities, venting, and plumbing. The heater shall be insulated to meet current ASHRAE 90.1standby loss requirements and jacketed with powder-coated steel panels. Pressure vessel shall include a ball-type drain valve.

2.3 TRIM AND ACCESSORIES

A. Electronic flame monitoring.

B. Immersion operating thermostat and immersion temperature limiting device.

C. ASME rated temperature and pressure relief valve

D. Operating and safety controls shall meet the requirements of UL 795.

E. The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to the facility’s building management system (BMS) through BACNET, Modbus protocol, etc as coordinated with the BMS contractor. The control will monitor all safeties and provide a 15-event history.

PART 3 EXECUTION

3.1 INSTALLATION

A. Maintain manufacturer's recommended clearances around and over water heaters.

B. Anchor water heaters on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater base on each side. Refer to Section 22 05 48.

C. Connect natural gas piping in accordance with NFPA 54.

D. Connect natural gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service.

E. Provide primary and secondary pressure regulators.

F. Connect domestic hot water and domestic cold water piping to supply and return water heater connections.

G. Install discharge piping from relief valves and drain valves to nearest floor drain.

H. Install control wiring between water heater control panel and field mounted control devices.

3.2 MANUFACTURER'S FIELD SERVICES

A. Division 01 - Quality Requirements: Requirements for manufacturer's field services.

B. Test and start-up equipment in accordance with manufacturer's start-up instructions.

C. Adjust all parameters in accordance with manufacturer recommendations.

3.3 CLEANING

A. Clean all devices upon completion of Work.

3.4 DEMONSTRATION AND TRAINING

A. Division 01 – Demonstration and Training. Requirements for demonstration and training.

B. Demonstrate operation and maintenance procedures.

C. Furnish services for manufacturer's technical representative for four hours to instruct Owner's personnel in operation and maintenance. Schedule training with Owner, provide at least 7 day's notice to Architect/Engineer of training date.

END OF SECTION

SECTION 224000

PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks including clinic sinks and surgical scrub sinks.
5. Service sinks.
6. Electric water coolers.
7. Showers.
8. Emergency Eye and Face Wash.
9. Emergency Combination Shower with Eye and Face Wash.

B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 00 – Common Work Results for Plumbing.
3. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
4. Division 26 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

B. Air-Conditioning and Refrigeration Institute:
1. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.

C. American Society of Mechanical Engineers:
1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
2. ASME A112.18.1 - Plumbing Fixture Fittings.
3. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
4. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
5. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
6. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
7. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.

D. Safe Drinking Water Act.
1. SDWA 1417 - Standard for Lead Free Drinking Water.

1.3 SUBMITTALS

A. Division 01 - Submittal Procedures

B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes. Clearly indicate on submittal "Lead Free" where required.

C. Manufacturer's Installation Instructions: Submit installation methods and procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.5 QUALITY ASSURANCE

A. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc., testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

B. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.

C. All plumbing fixtures and associated trim including faucets, valves, stops and water dispensers that are part of the domestic water system shall be lead free in accordance with SDWA 1417. Exclusions include toilets, bidets, urinals, fill valves, flush-o-meter valves, tub fillers, and main gate valves that are 2-inches and larger.

D. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.9 WARRANTY

A. Division 01 - Warranties and Bonds: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for plumbing fixtures.

1.10 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two sets of: Faucet service kits, flush valve service kits, lavatory supply fittings and toilet seats

PART 2 PRODUCTS

2.1 FLUSH VALVE WATER CLOSETS

A. Manufacturers:
1. American Standard Plumbing
2. Sloan
3. Kohler Co.

B. Bowl: ASME A112.19.2M; wall hung, vitreous china closet bowl, with elongated rim, 1-1/2 inch top back spud, china bolt caps.

C. Bowl: ASME A112.19.2M; floor mounted, siphon jet 17 inch bowl height, ADA accessible vitreous china closet bowl, with elongated rim, 1-1/2 inch top back spud, china bolt caps.

D. Flush Valve Manufacturers:
1. Sloan
2. Zurn
3. Hydrotek

E. Electrically Operated Flush Valve: ASME A112.18.1; exposed chrome plated brass, diaphragm type, vacuum breaker; maximum 1.28 gallon flush volume.

F. Seat: Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, with without cover.

2.2 WALL HUNG URINALS

A. Manufacturers:
1. American Standard Plumbing
2. Sloan
3. Kohler Co.
4. Crane

B. Urinal: ASME A112.19.2M or ANSI Z124.9, vitreous; vitreous china, wall hung urinal with shields, integral trap, removable stainless steel strainer, top spud, steel supporting hanger.

C. Manually Operated Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type, wheel handle stop and vacuum breaker; maximum 0.125 gallon flush volume.

D. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

E. Provide elastomeric gasket complying with ASME A112.4.3, or approved setting compound, for fixture to flange connection.

2.3 LAVATORIES

A. Manufacturers:
1. Acorn
2. American Standard Plumbing
3. Sloan
4. Kohler Co.
5. Crane

B. Vitreous China Wall Hung Basin: ASME A112.19.2M; vitreous china wall hung lavatory, with 4 inch high back, drillings on 4 inch 8 inch centers, rectangular basin with splash lip, front overflow, and soap depression.

C. Faucet: ASME A112.18.1, SDWA 1417; chrome plated lead free mixing faucet; hard wired, solenoid operator and infrared sensor, 1.0 gpm aerator spray and cover plate, open grid strainer.

D. Waste Fittings: ASME A112.18.2 or ASTM F 409.

E. For public hand washing facilities, provide tempered water through regulating device conforming to ASSE 1070.

F. Accessories:
1. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
2. Offset waste with perforated open strainer plug and strainer.
3. Lead free Screwdriver stops.
4. Lead free Flexible supplies.
5. Trap and waste insulated and offset to meet ADA compliance.

G. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.

2.4 SINKS

A. Manufacturers:
1. Steris
2. Elkay
3. American Standard Plumbing
4. Eljer
5. Kohler Co.
6. Crane

B. Single Compartment Bowl: ASME A112.19.3, 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch chromed brass drain 3-1/2 inch crumb cup and tailpiece, ledge back drilled for trim.

C. Double Compartment Bowl: ASME A112.19.3; 18 gage 20 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch chromed brass drains 3-1/2 inch crumb cups and tailpieces, ledge back drilled for trim.

D. Trim: ASME A112.18.1, SDWA 1417; refer to schedules on the drawings.

E. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, lead free wheel handle screwdriver stop, lead free flexible supplies.

2.5 ELECTRIC WATER COOLERS

A. Manufacturers:
1. Elkay
2. Hasley Taylor
3. Haws
4. Acorn/Murdock
5. Filtrine
6. Oasis

B. Fountain:
1. ARI 1010; semi-recessed handicapped mounted electric water cooler with stainless steel top, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket, refrigerated with integral air cooled condenser and stainless steel grille and bottle filler.
2. Capacity: gpm of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
3. All components of the electric water cooler in the wetted surface material shall be lead free in accordance with SDWA 1417.
4. Furnish with cane apron and mounting bracket.

2.6 JANITOR'S SINKS

A. Manufacturers:
1. Acorn
2. Fiat
3. Kohler Co.
4. Just

B. Bowl: 36 x 24 x 10, 24x24x10 inch high molded stone, floor mounted, with one inch wide shoulders, vinyl bumper guard, stainless steel strainer.

C. Trim: ASME A112.18.1 exposed wall type supply with cross lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral lead free screwdriver stops with covering caps and adjustable threaded wall flanges.

D. Accessories:
1. 5 feet of 1/2 inch diameter plain end reinforced plastic rubber hose.
2. Hose clamp hanger.
3. Mop hanger.

2.7 EMERGENCY EYE WASH AND COMBINATION SHOWER WITH EYE AND FACE WASH

A. Manufacturers: Guardian, no substitutions.

B. Shower: ANSI Z358.1; free standing, self- cleaning, non-clogging 8 inch diameter plastic drench shower head, instant action stay open valve actuated by rigid stainless steel pull rod.

C. Eyewash: ANSI Z358.1; stainless steel bowl with elbow, 1-1/4 inch galvanized steel pipe pedestal with floor flange, instant action stay open valve actuated by push flag l, twin spray heads with face spray ring, dust cover assembly, wall mount bracket, and tailpiece and chrome plated brass P-trap.

D. Supply and Waste Piping: 1-1/4 inch stainless steel pipe pedestal with floor flange.

E. Furnish universal emergency sign.

2.8 LAVATORY INSULATION KIT

A. Manufacturers:
1. McGuire
2. Truebro
3. Plumerex

B. Product Description: Where Lavatories are noted to be insulated for ADA compliance, furnish the following: Safety Covers conforming to ANSI A177.1 and consisting of insulation kit of molded closed cell vinyl construction, 3/16 inch thick, white color, for insulating tailpiece, P-trap, valves, and supply piping. Furnish with weep hole and angle valve access covers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify walls and floor finishes are prepared and ready for installation of fixtures.

C. Verify electric power is available and of correct characteristics.

D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. At domestic water and waste pipe connections to all fixtures, equipment, etc. provide isolation valves and unions.

C. Provide chrome plated rigid or flexible lead free supplies to fixtures with loose key stops, reducers, and escutcheons.

D. Install components level and plumb.

E. Install and secure fixtures in place with wall supports wall carriers and bolts.

F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 90 00, color to match fixture.

G. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

H. For ADA accessible water closets, install flush valve with handle to wide side of stall.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.5 ADJUSTING

A. Division 01 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Division 01 - Execution and Closeout Requirements: Final cleaning.

B. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Division 01 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit use of fixtures before final acceptance.

END OF SECTION

SECTION 226013

MEDICAL GAS AND VACUUM SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Medical gas piping and accessories.
2. Medical gas equipment and accessories.
3. Valves.
4. Pipe hangers and supports.
5. Medical gas valve boxes
6. Medical gas outlets.
7. Compressed air source system.
8. Medical air compressor.
9. Medical vacuum / waste anesthetic gas pump.
10. Gas cylinder manifolds and pressure reducing stations.
11. Area alarm panel.
12. Master alarm panel.
13. Labeling and identification.
14. Wiring.
15. Installer performed tests.
16. System verification tests.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment
4. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
5. Division 26 – Electrical

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
3. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Society of Sanitary Engineering:
1. ASSE 6010 - Professional Qualification Standard for Medical Gas and Vacuum System Installers.
2. ASSE 6030 - Medical Gas Verifiers Professional Qualification Standard.

C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS B2.2 - Standard for Brazing Procedure and Performance Qualifications.
3. AWS D1.1 - Structural Welding Code - Steel.

D. ASTM International:
1. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
2. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
3. ASTM A403/A403M - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
6. ASTM B32 - Standard Specification for Solder Metal.
7. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
8. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
9. ASTM B819 - Standard Specification for Seamless Copper Tube for Medical Gas Systems.
10. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
11. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
12. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings.
13. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
14. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
15. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
16. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
17. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
18. ASTM F437 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
19. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
20. ASTM F441 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedule 40 and 80

E. Compressed Gas Association:
1. CGA G-4.1 - Cleaning Equipment for Oxygen Service.
2. CGA C-7 - Guide to the Preparation for Cautionary Labeling and Marking for Compressed Gas Containers.
3. CGA V-1 - Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections.
4. CGA V-5 - Diameter-Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications).

F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 67 - Butterfly Valves.
3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
4. MSS SP 73 - Brazed Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings.

5. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

G. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

H. National Fire Protection Association:
1. NFPA 50 - Standard for Bulk Oxygen Systems at Consumer Sites.
2. NFPA 99 - Health Care Facilities.

I. Underwriters Laboratories Inc.:
1. Electrical Construction Equipment.

1.3 SYSTEM DESCRIPTION

A. Systems shall be Level 1 Medical Gas Systems include the following gas types, piping systems and equipment.

1.4 SUBMITTALS

A. Division 01 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings:
1. Indicate piping system schematic with electrical and connection requirements general assembly of components, mounting and installation details.
2. Indicate general layout of control and alarm panels.
3. Indicate detailed medical wall assembly drawings.

C. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. System Components: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes. When applicable, include electrical characteristics and connection requirements.
5. Compressors: Submit type, capacity, and performance characteristics. Include electrical characteristics and connection requirements.
6. Vacuum Pumps: Submit type, capacity, and performance characteristics. Include electrical characteristics and connection requirements.

D. Product Data: Submit manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.

E. Qualifications Data: Submit documentation verifying qualifications for the following:
1. Brazers and brazing procedures.
2. Welders and welding procedures.
3. Medical gas system installer.
4. System verifier.

F. Samples: Submit on sample of each type of outlet.

G. Manufacturer's Field Reports: Indicate systems are complete, zone valves installed, and alarm systems functional.

H. Installer's Test Reports:
1. Submit documentation indicating completion of Installer Performed Tests.
2. Submit list of each test and when test was completed.
3. Include documentation required by NFPA 99.

I. Verifier's Test Reports:
1. Submit testing and inspection report of System Verification Tests.
2. Submit list of each test and when test was completed.
3. Include documentation required by NFPA 99.

1.5 WIRING

A. Installation of the wiring shall be by skilled electricians, properly licensed, trained and qualified for this work.

B. Installation shall be in accordance with NFPA 99, NEC and Division 26 of these specifications.

C. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.

D. Do not install wiring in conduit containing wiring for other systems.

E. All concealed wiring shall be installed in EMT conduit.

F. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to wire connections shall be at a terminal block. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

G. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

H. Follow manufacturer's installation recommendations for all communication wiring and network cabling. Network or communication cabling shall be run separately from other wiring.

I. Supervision and checkout of the system shall be by manufacturer of medical gas equipment.

J. Provide wiring between each pipe mounted remote sensor and respective Area Alarm Panel.

K. Provide wiring between each pipe mounted remote sensor and both Master Alarm Panels.

L. Provide wiring between Medical Gas Equipment and both Master Alarm Panels.

M. Provide Ethernet connection between each Area Alarm Panel and each Master Alarm Panel.

1.6 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of equipment piping, valves, outlets and components.

C. Operation and Maintenance Data: Submit assembly views, lubrication instructions, replacement part numbers and availability.

1.7 QUALITY ASSURANCE

A. Oxygen Systems: Furnish piping, valves, pipe fittings, outlets and other piping components cleaned by manufacturer in accordance with CGA G-4.1. Furnish documentation certifying installed piping materials comply with CGA G-4.1 cleaning requirements.

B. Perform Work in accordance with NFPA 99 for installation of piping systems and ASME Section IX and AWS B2.2 for brazing materials and procedures.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.
   1. ASSE Standard 6010 qualified to install medical gas and vacuum systems.

C. Brazers and Brazing Procedures: ASME Section IX and AWS B2.2 qualified within previous 12 months for medical gas and vacuum systems.

D. Welders and Welding Procedures: AWS D1.1 qualified within previous 12 months for medical gas and vacuum systems.

E. System Verifier: Company specializing in performing work of this section with minimum three years documented experience.

1.9 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

C. Convene additional meetings minimum one week prior to commencing the following:
   1. Installer performed tests.
   2. System verification tests.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept equipment on site in factory fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

C. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.11 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five year manufacturer warranty for vacuum pumps and compressors.

1.12 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Requirements for extra materials.

B. Furnish two of each spring, poppet and O-ring for each type of medical gas outlet.

C. Furnish one pipe mounted / remote digital pressure sensor for each type of medical gas system for a total of seven sensors.

PART 2 PRODUCTS

2.1 LEVEL 1 POSITIVE PRESSURE MEDICAL GAS SYSTEM PIPING

A. Specification includes piping for:
1. Medical Air.
2. Oxygen.
3. Nitrous Oxide.
4. Nitrogen.
5. Carbon Dioxide.

B. Piping All Sizes, Below Gage Pressure of 185 psig:
1. Copper Tubing: ASTM B819, Type L. Furnish piping identified with manufacturer’s markings.

C. Piping All Sizes, Above Gage Pressure of 185 psi:
1. Copper Tubing: ASTM B819, Type K. Furnish piping identified with manufacturer’s markings.

D. Fittings: ASME B16.22, wrought copper and bronze or MSS SP 73 wrought and cast copper; prepared in accordance with NFPA 99.

E. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting temperature range 1190 to 1480 degrees F.

F. Buried Piping shall be installed within Protector Piping: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material.
1. Fittings: ASTM D2466, Schedule 40, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

3. 3” oxygen piping shall be installed in 6” Protector Piping.

2.2 LEVEL 1 MEDICAL SURGICAL VACUUM SYSTEM PIPING

A. Specification includes piping for:
1. Medical Vacuum.
2. Waste Anesthetic Gas Disposal (WAGD).

B. Copper Tubing: ASTM B819, Type L. Furnish piping identified with manufacturer’s markings.

C. Fittings: ASME B16.22, wrought copper and bronze or MSS SP 73 wrought and cast copper; prepared in accordance with NFPA 99.

D. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting temperature range 1190 to 1480 degrees F.

2.3 MEDICAL AIR INTAKE PIPING AND MEDICAL VACUUM EXHAUST PIPING

A. Copper Tubing: ASTM B88, Type L, drawn.

B. Fittings: ASME B16.18 cast copper alloy or ASME B16.22, wrought copper and bronze.

C. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting temperature range 1190 to 1480 degrees F.

2.4 RELIEF VALVE VENT PIPING

A. Copper Tubing: ASTM B88, Type L, drawn.

B. Fittings: ASME B16.18 cast copper alloy or ASME B16.22, wrought copper and bronze.

C. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting temperature range 1190 to 1480 degrees F.

2.5 PURE WATER PIPING, VALVES AND ACCESSORIES

A. Piping: ASTM F439, Schedule 80, chlorinated polyvinyl chloride (CPVC) material.

B. Fittings: ASTM F441, Schedule 80 CPVC with socket or threaded ends.

C. Joints: Solvent weld with ASTM F493 solvent cement. Prime joints with a contrasting color.

D. Unions: Solvent-weld socket to screwed joint adapters and unions, ASTM D2464, Schedule 80 CPVC.

E. Ball Valves:
1. Manufacturers: Spears True Union 2000 or approved equal as manufactured by Nibco or Hayward.
2. Schedule 80 CPVC with socket or threaded ends, quarter turn handle.

2.6 COMPRESSED AIR PIPING, VALVES AND ACCESSORIES (LAB AIR)

A. Copper Tubing: ASTM B88, Type L drawn.
   1. Fittings: ASME B16.18 cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

B. Unions, dielectric fittings and flanges:
   1. Unions: Copper Piping, Class 150, bronze unions with soldered brazed joints.
   2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
   3. Flanges: Copper Piping: Class 150, slip-on bronze flanges and 1/16 inch thick preformed neoprene gaskets.

C. Ball Valves:
   1. Nibco or approved equal by Crane Valve, Milwaukee Valve Company, Stockham, or Watts
   2. 2 inches and Smaller: MSS SP 110, Class 150 bronze, two piece body, chrome plated bronze l ball, full port, teflon seats, blow-out proof stem, solder ends with union, lever handle.
   3. 2-/12 inches and Larger: MSS SP 110, Class 150 bronze, two piece body, chrome plated bronze l ball, full port, teflon seats, blow-out proof stem, solder ends with union, lever handle.

2.7 UNIONS AND FLANGES - LEVEL 1 POSITIVE PRESSURE AND VACUUM MEDICAL GAS SYSTEMS

A. Unions and Dielectric Connections for Pipe 2 inches and Smaller: Class 150, bronze unions with brazed joints.

B. Flanges for Pipe 2-1/2 inches and Larger: Class 150, slip-on bronze flange and 1/16 inch thick preformed neoprene gaskets.

2.8 BALL VALVES - LEVEL 1 POSITIVE PRESSURE AND VACUUM MEDICAL GAS SYSTEMS

A. Manufacturers:
   1. Allied Health Care
   2. Amico Corporation
   3. Beacon Medical Products
   4. Crane Valve, North America
   5. Hammond Valve
   6. Milwaukee Valve Company
   7. Stockham Valves & Fittings

B. Valves 2 inches and Smaller: MSS SP 110, 600 psi non-shock working pressure, bronze, three piece body, chrome plated bronze ball, full port, teflon seats, blow-out proof stem, solder ends with extensions for brazing, locking lever handle.
   1. Furnish valves cleaned for oxygen service in accordance with CGA G-4.1 by manufacturer and labeled, sealed, and packed for shipping.

C. Locks: Furnish padlock with keyway to match all medical gas valves.

2.9 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
1. Carpenter & Paterson Inc.
2. Flex-Weld, Inc.
3. Globe Pipe Hanger Products Inc.

B. Conform to MSS SP 58.

C. Furnish hangers for copper piping system with copper finish and sized for copper pipe.

2.10 MEDICAL GAS ZONE VALVE BOXES / CABINETS

A. Manufacturers:
1. Beacon Medical Products
2. Allied Health Care
3. Amico Corporation

B. Valve Cabinets:18 gauge steel with white epoxy finish, recessed, and rigidly assembled to accommodate valves and fittings, punched or drilled sides to receive tubing, anchors to secure to wall construction. Provide with two 18 gauge galvanized steel adjustable mounting brackets.
1. Vertical Configuration: Valves shall be arranged vertical with pipe connections on the top of the cabinet.
2. Overall Size: Sized to accommodate number of valves indicated on Drawings.
3. Cover Plates: Provide with replaceable plastic windows with pull ring to remove window.
4. Ports: Provide minimum (3) 1/8” ports for purging and mounting alarm sensors within the cabinet. Provide punch out on top for electrical wiring of pressure sensors.
5. Cabinet Labels: Labeled and color coded for intended service and area served in accordance with NFPA 99.
6. Valves: Furnish with Level 1 medical gas ball valves as specified in this section. Extensions furnished with gage port on outlet side of valve.
7. Gages: Furnish 1-1/2 inch diameter pressure gauge for each medical gas.

2.11 FLEXIBLE PIPE CONNECTORS FOR EQUIPMENT CONNECTIONS

A. Manufacturers:
1. Flex-Hose Co., Inc.
2. Flex-Weld, Inc./Keflex
3. The Metraflex Company
4. Twin City Hose, Inc.

B. Corrugated bronze hose with single layer of bronze exterior braiding, copper tubing ends; maximum working pressure 190 psig, brazed ends. Minimum burst pressure of 1000 psi.
1. 12” maximum length.
2. Furnish cleaned for oxygen service by manufacturer and labeled, sealed, and packed for shipping.

2.12 PRESSURE GAGES

A. Manufacturers:
1. Dresser Instruments, Dresser, Inc.
2. Dwyer Instruments, Inc.

3. H. O. Trerice Co.
4. Weiss Instruments, Inc.

B. Gage: ASME B40.1 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
1. Case: Cast aluminum.
2. Bourdon Tube: Brass.
3. Dial Size: 3-1/2 inch to 4 inch diameter.
4. Mid-Scale Accuracy: 1percent of full scale at point of reading.
5. Furnish gages with demand check fitting.
6. Furnish gages cleaned for oxygen service by manufacturer and labeled, sealed, and packed for shipping.

2.13 MEDICAL GAS OUTLETS

A. Manufacturers:
1. Allied Health Care
2. Amico Corporation
3. Beacon Medical Products

B. Style: Diameter Index Safety System (DISS) in accordance with CGA V-5 compatible with Owner’s standards.

C. Furnish outlets with the following features:
1. Recessed mounting.
2. Face Plates: Epoxy coated or plastic faceplate with Lexan cover, color-coded with embossed labeling
3. Non-interchangeable connectors, automatic valves, secondary check valves (except vacuum and evacuation outlets), and capped 3/8 inch tubing stubs for supply connections, color coded and labeled for intended service.
4. Latch mechanisms designed for one handed, single thrust mounting and one handed fingertip release of secondary equipment.
5. Furnish outlets cleaned for oxygen service by manufacturer and labeled, sealed, and packed for shipping.

D. Vacuum Bottle Brackets: Stainless steel, chrome-plated metal, or aluminum with finish matching adjacent outlet.

2.14 UNDERGROUND PIPE MARKERS

A. Manufacturers:
1. Craftmark
2. Safety Sign
3. Seton

B. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

C. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Medical Oxygen Service” in large letters.

2.15 LABELING AND IDENTIFICATION

A. Furnish labeling and identification in accordance with NFPA 99.

B. Pipe Labels:
1. Furnish pipe labels or stenciling identifying the medical gas or vacuum system. Furnish with name of gas or vacuum system or chemical symbol.
2. Furnish pipe labels with colors in accordance with NFPA 99.
3. When gas system operates at other than standard pressures, include operating pressure in addition to gas name.

C. Valve Labels:
1. Label all valves in accordance with NFPA 99.
2. Furnish valve with name of gas or vacuum system. Label with room or area served. Label with caution to not open or close valve in an emergency.
3. When gas system operates at other than standard pressures, label valve with operating pressure in addition to gas name.

D. Cylinders: Label cylinder contents in accordance with CGA C-7.

E. Outlets and Inlets:
1. Furnish with name of gas or vacuum system or chemical symbol.
2. When gas system operates at other than standard pressures, include operating pressure in addition to gas name.

F. Alarm Panels:
1. Label indicating condition monitored.
2. Label each panel for area of surveillance.

2.16 NITROGEN GAS CONTROL PANEL / PRESSURE REGULATOR

A. Manufacturers:
1. Allied Health Care
2. Amico Corporation
3. Beacon Medical Products

B. Recessed panel with shut-off valve, inlet and outlet pressure gauges (2-1/2” diameter), adjustable pressure regulator with dial and DISS outlet.

2.17 GAS CYLINDER CHANGEOVER MANIFOLD

A. Manufacturers:
1. Beacon Medeas Lifeline Products
2. Allied Health Care
3. Amico Corporation

B. Duplex Automatic Manifold: Consisting of wall mounted control cabinet, header connections, and pigtails for cylinders. Furnish automatic changeover from primary to secondary bank and allow replacing depleted cylinders with no change in line pressure. For quantity of cylinders, refer to drawings.

C. By-pass System: Between regulators to service regulator or switch over system without interrupting supply of gas. Pipe bleed valves to vent connector within cabinet to allow adjustment of pressure regulators.

D. Cabinet: House components in locking cabinet with NEMA 4 enclosure and baked enamel finish.
1. Three front mounted gages indicate header and line pressures.
2. Furnish pressure switches to activate signals.
3. Furnish terminal block connections for remote alarms.

E. Pressure Regulators: Furnish duplex pressure regulators installed in parallel with shutoff valves before each regulator and shutoff or check valve after each regulator.

F. Relief Valve: Brass or bronze body, seat and trim compatible with gas service, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

G. Electrical Characteristics:
1. 120, single phase, 60 Hz.
2. 2 amperes maximum.
3. Provide with disconnect switch.
4. Minimum (2) dry contacts for connection to remote alarms.

2.18 AREA ALARM PANELS

A. Manufacturers:
1. Beacon Medaes Total Alert Infinity or approved equal by:
a. Allied Health Care
b. Amico Corporation

B. Compliance with:
1. NFPA 99, latest edition.
2. ETL Listed to UL 1069.

C. Modular, self-monitoring type, to monitor medical gas systems shown on the drawings.
1. Green light for systems normal.
2. High or low pressure alarm:
a. Green light extinguishes.
b. Audible warning device sounds.
c. Red light energizes.
3. Mute button silences alarm warning.
4. Mute indicating LED
5. Warning LED for trouble alert.
6. Digital readout indicates pressure or vacuum.
7. Digital readout indicates location.
8. Furnish system with internal processor and transformer.
9. Capable of monitoring up to eight (8) gases.
10. History event log for most recent 100 events.
11. Ethernet connection for interconnection with Master Alarm Panels.

D. Screen:
1. 10” LCD touch screen display.
2. Input Power: 120 volt, single phase

E. Pipe Mounted / Remote Digital Sensors:
1. Gas specific with transducer to provide factory calibrated signals to the panel.
2. Sensor shall be remote mounted / pipe mounted.
3. Green flashing LED light to indicate proper operation.

2.19 MASTER ALARM PANELS

A. Manufacturers:
1. Beacon Medaes Total Alert Infinity or approved equal by:
a. Allied Health Care
b. Amico Corporation

B. Compliance with:
1. NFPA 99, latest edition.
2. ETL Listed to UL 1069.

C. Modular, self-monitoring type, to monitor medical gas systems shown on the drawings.
1. Green light for systems normal.
2. High or low pressure alarm:
a. Green light extinguishes.
b. Audible warning device sounds.
c. Red light energizes.
3. Mute button silences alarm warning.
4. Mute indicating LED
5. Warning LED for trouble alert.
6. Digital readout indicates pressure or vacuum.
7. Digital readout indicates location.
8. Furnish system with internal processor and transformer.
9. Capable of monitoring up to six (60) dry contact remote signals
10. Capable of monitoring up to eight (8) area alarm panels and display up to 320 signals.
11. History event log for most recent 100 events.
12. Ethernet connection for interconnection with Area Alarm Panels.

D. Screen:
1. 10” LCD touch screen display.
2. Input Power: 120 volt, single phase

E. Pipe Mounted / Remote Digital Sensors:
1. Gas specific with transducer to provide factory calibrated signals to the panel.
2. Sensor shall be remote mounted / pipe mounted.
3. Green flashing LED light to indicate proper operation.

2.20 MEDICAL AIR COMPRESSOR

A. Manufacturers:
1. Beacon Medaes or approved equal by:
a. Allied Health Care
b. Amico Corporation

B. Provide a complete medical air source, complying with all relevant requirements of NFPA 99. Furnish a complete plant consisting of compressors, receiver, air treatment system and controls capable of providing capacity as scheduled on the drawings with one compressor out of service. System shall be furnished as a duplex.

C. System shall be entirely on two bases and each base shall be prepared for separation from the factory. Each base shall fit through a standard 36 inch door frame. System shall be pre-wired, pre-piped and assembled on each base with single point connections for electrical, intake air, discharge air. All piping shall be factory complete including all valves.

D. System base, frames, control cabinet and receiver are powder coated.

E. The compressor modules and motors shall be fully isolated from the main compressor base by means of a four point, heavy-duty isolation system for a minimum of 95% isolation efficiency. System is engineered for equal weight distribution between four isolation points.

F. Flexible connections between compressor units and the structure shall be provided for all inlets and outlets. Inlet flexes shall be corrugated metal with outer stainless braid. Outlet flexes shall be metal and double wall with thermal isolation.

G. The compressors shall be a continuous duty rated scroll type. The design shall be single stage, air-cooled, consisting of one fixed and one orbiting scroll sealed with PTFE tip seals between the scroll halves and rated for 828 kPa (120 PSIG) discharge pressure. Orbiting bearings shall be grease filled. Compressors shall be field serviceable for tip seal change and bearing lubrication. Noise level shall not exceed 75 dB(A) for duplex system, with pumps running at peak demand. Belt tensioning shall be achieved with a sliding motor mounting base adjustable with two tensioning screws. Each compressor unit shall be equipped with a distinct after cooler with separate cooling fan designed for a maximum approach temperature of 7°C (15°F) at 37.8°C (100°F) ambient and complete with electronic drain valve. The discharge of piping of each compressor shall incorporate an electronic solenoid valve to prevent reverse rotation of the scroll at shutdown.

H. Control system shall be contained in a cabinet factory prepunched for conduit connections. Provide three punches: for power in sized per NFPA 70 Article 310 and based on total system amperes, for communications and for master alarm wiring, each sized for ½" EMT conduit. The control system shall be built and labeled in a UL approved panel shop operating under ISO 13485 Medical Device registration. The control panel shall have a SCCR Rating of 65K amperes RMS. Panels with rating of less than 65K shall be unacceptable. Provide in the control system door:
   1. 16 bit, full color, VGA resolution touch screen display for system functions and system level control
   2. Separate 16 bit, full color half VGA resolution touch screen for display of compressor unit functions and compressor unit control. These controls provide selector control of Automatic, Manual (continuous run) or Off for each compressor unit.
   3. Screens shall turn off when not in use to preserve screen life.
   4. A separate disconnect handle with door interlock for each compressor unit.
   5. Audio sounder capable of 80 dB at 3 feet with mute function provided by the controls.
   6. Power on lamp illuminated whenever any disconnect is On.
   7. Means for automatically deactivating the screen saving function.

I. Provide in the control cabinet interior:
   1. Full voltage motor starters with overload protection, one per compressor unit.
   2. Circuit breaker disconnects, one for each compressor unit operated by the through the door disconnect handle.
   3. Redundant 24 Volt DC control circuit transformers including power seeking function in the event one power supply fails.

4. Power distribution terminal block convenient for main power entry.
5. All internal circuit boards and components needed for operation of the control system.
6. Volt free contacts for connection to master alarms.
7. Controls circuitry shall be 24 Volts DC for worker safety. No system component other than the drive motors shall require greater than 24V for operation.

J. The control system shall provide for the following functionality:
1. Display of pressure, dew point and carbon monoxide level on a single display for at a glance checking.
2. Automatic lead/lag sequencing and alternation. Display clearly shows status of each compressor unit including running unit, next-unit-in-sequence, and units unavailable to run.
3. Runtime hour-meters for each compressor unit.
4. In the event of control failure the system shall activate all alarms and operate on a simple on/off basis until repaired.
5. When H-O-M selectors are in Manual mode, system will operate on pressure switch and compressor units will not run if lead switch is satisfied.
6. Visual and audible alarm indication and isolated contacts for remote alarm for at least Dew Point High, CO High, Lag Compressor in Use, and High Temperature (for each compressor unit alone or system together).
7. Continuous monitoring of ambient temperature.
8. Automatic indication of major maintenance intervals and details of required maintenance kits.
9. Distinct separate indication on the control screens of alarms which shutdown the compressor vs. alarms which do not shut down the compressor vs. maintenance notifications.
10. Control and observation of dryer operation from control panel with controls integral to touchscreen system. System includes maintenance alerts and diagnostics for dryers.
11. Isolated contacts for remote alarms which can distinguish between a condition which shuts down the unit, a condition which does not shut down the system and a maintenance alert.
12. Permit individual test of Dew point, CO, lag in use, high temperature and controls fault alarm points from the touchscreen. System shall include low level testing of controls, local and connected master (source) alarms.
13. One-person “bumping” of the compressors to test rotation.
14. Logs and allows review of all alarm and shutdown events.
15. Logs and allows review of all maintenance events.
16. Control system is highly redundant and robust allowing for multiple failures before becoming unable to make air. Control systems which can lose any single component and fail to make air are not acceptable.
17. Controls include an integral webserver using standard Ethernet allowing observation of system operating parameters from any remote location on the same network with any standard web browser.

K. Compressor motors shall be a NEMA Premium Efficiency rated, open drip proof unit with 1.15 service factor suitable for 208 or 230/460 volt, three phase, 60hz.

L. All moving parts (fans, pulleys and belts) shall be fully protected by OSHA acceptable enclosures and guards.

M. A temperature sensor at the outlet of each compressor cylinder or air-end to provide high temperature alarm and shutdown that compressor..

N. Provide redundant medical air treatment systems including desiccant dryers, filters, and purifiers sized for NFPA system output. Include dew point and carbon monoxide monitoring. Medical air treatment shall include:
   1. Desiccant dryers producing a 10°F (-12°C) pressure dew point.
   2. Dryer purge flow control through an integral dew point based purge control system. Purge controllers using desiccant temperature are not acceptable.
   3. 441 transfer valve utilizing two ceramic slide plates. Units utilizing multiple solenoids or diaphragm type switching are not acceptable. Valve shall require no periodic service and be covered by a 5 year factory warranty.
   4. Mounted coalescing pre-filter rated for 0.01 micron with automatic drain and element change indicator at the inlet to each dryer.
   5. Final line filters rated for 0.1 micron with element change indicators (per NFPA 99 5.1.3.5.8(3)&(4)), duplexed final line regulators, and duplexed safety relief valves shall be factory mounted and piped at the outlet of each dryer.
   6. Sensors for dew point and CO sensors are provided with a DISS demand check.

O. System piping is welded except where unions are required for service or where piping connects to valves or system components. Main flow path joints shall be flanged and provided with seals, use 37° SAE flares suitable for flare tight seals or SAE straight thread with O-ring seal for leak tight connection and ease of replacement or service. NPT fitting use shall be minimal.

P. Provide corrosion resistant, powder coated, ASME Coded, National Board Certified receiver rated for a minimum 150 PSIG design pressure. Include a liquid level glass with bead, safety relief valve, manual drain valve, and zero loss tank drain.

Q. The complete medical air system and all electrical components shall be factory pretested prior to shipment.

2.21 MEDICAL VACUUM PUMP

A. Manufacturers:
   1. Beacon Medaes or approved equal by:
      a. Allied Health Care
      b. Amico Corporation

B. Provide a complete medical vacuum source, complying with NFPA 99. All components shall be provided with isolation valves and check valves to permit service to any component without interrupting vacuum supply to the facility during any maintenance operation or any condition of single fault failure. Furnish complete plant consisting of pumps, receiver and controls capable of providing the scheduled capacity with one pump out of service. System shall be furnished as a triplex.

C. System shall be entirely on two bases and bases shall be prepared for separation from the factory. Each base shall fit through a standard 36 inch door frame. System shall be pre-wired, pre-piped and assembled on each base with single point connections for electrical, intake air, discharge air. All piping shall be factory complete including all valves.

D. System piping shall incorporate O-ring sealed flanges and SAE O-ring or flare fittings for minimum leaks and easy repair. Valves are butterfly or ball type, positive seal with three piece disassembly.

E. System base, frames, control cabinet, piping and receiver shall be powder coated.

F. Each pump shall be included with corrugated metal inlet and outlet flex connectors factory installed.

G. Provide non contacting claw style rotary pumps. Internal construction shall be friction free and rotors are non-contacting. Air end is oil free and requires no sealants. Each pump shall be air cooled and continuous duty rated. Pump shall be provided with a single lubricated gearbox requiring oil change not more often than annually. Each pump shall be provided with exhaust and equipped with high vacuum shutdown and high temperature shutdown. Provide in the control system a single Variable Speed Drive Inverter and separate across the line motor contactors. One pump normally runs on the variable speed and others as required shall run across the line.

H. Each pump will be direct or close coupled to a NEMA rated Premium Efficiency TEFC motor with a service factor of 1.25.

I. Control system shall be provided with pre-punched for conduit connections. Provide three punches: for power in sized per NFPA 70 Article 310 and based on total system amperes, for communications and for master alarm wiring, each sized for ½" EMT conduit. The control system shall be built and labeled in a UL approved panel shop operating under ISO 13485 (Medical Device) registration. The control panel shall have a SCCR Rating of 65K amperes RMS. Provide in the control system door:
   1. 16 bit, full color, VGA resolution touch screen display for system functions and system level control.
   2. Separate 16 bit, full color half VGA resolution touch screens for display of pump functions and pump control. These controls provide selector control of Automatic, Manual (continuous run) or Off for each pump.
   3. Screens shall turn off when not in use to preserve screen life.
   4. A separate disconnect handle with door interlock for each pump.
   5. Audio sounder capable of 80 dB at 3 feet with mute function provided by the controls.
   6. Power on lamp illuminated whenever any disconnect is On.
   7. Means for automatically deactivating the screen saving function.

J. Provide in the control cabinet interior:
   1. Full voltage motor starters with overload protection, one per pump.
   2. Circuit breaker disconnects, one for each pump operated by the through the door disconnect handle.
   3. Redundant 24 Volt DC control circuit transformers including power seeking function in the event one power supply fails.
   4. Power distribution terminal block convenient for main power entry.
   5. All internal circuit boards and components needed for operation of the control system as described below.
   6. Volt free contacts for connection to master alarms.
   7. Controls circuitry shall be 24 Volts DC for worker safety. No system component other than the drive motors shall require greater than 24V for operation.

K. The control system shall provide for the following functionality:
   1. Display of vacuum and VSD speed on a single display for at a glance checking.
   2. Automatic lead/lag sequencing and alternation. Display clearly shows status of each pump including running unit, next-unit-in-sequence, and units unavailable to run.
   3. Runtime hour-meters for each pump.
   4. In the event of control failure the system shall activate all alarms and operate on a simple on/off basis until repaired.

5. When H-O-M selectors are in Manual mode, system will operate on vacuum switch and pump will not run if lead switch is satisfied.
6. Visual and audible alarm indication and isolated contacts for remote alarm for at least Lag Pump in Use.
7. Continuous monitoring of ambient temperature and on VSD models, continuous monitoring of cabinet interior temperature.
8. Automatic indication of major maintenance intervals and details of required maintenance kits.
9. Distinct separate indication on the control screens of alarms which shutdown the pump vs. alarms which do not shut down the pump vs. maintenance notifications.
10. Isolated contacts for remote alarms which can distinguish between a condition which shuts down the unit, A condition which does not shut down the system and A maintenance required event.
11. Control system permits individual test of lag in use, high temperature and controls fault alarm points from the touchscreen. System shall include low level testing of controls, local and connected master (source) alarms.
12. Controls facilitate one-person “bumping” of the pumps to test rotation.
13. Control system logs and allows review of all alarm and shutdown events.
14. An integral webserver using standard Ethernet allowing observation of system operating parameters from any remote location on the same network with any standard web browser.
15. BACnet capability.

L. The complete medical vacuum system and all electrical components shall be factory pre-tested prior to shipment.

2.22 AIR COMPRESSOR FOR LAB AIR

A. Manufacturers:
1. Beacon Medaes or approved equal by:
a. Allied Health Care
b. Amico Corporation

B. Furnish a complete plant consisting of compressors, receiver, air treatment system and controls. Compressor system shall be entirely on two bases and bases shall be prepared for separation from the factory. Each base shall fit through a standard 36 inch door frame. System shall be shall be pre-wired, pre-piped and assembled on each base with single point connections for electrical, intake air, discharge air. All piping shall be factory complete including all valves.

C. The compressor modules and motors shall be fully isolated from the main compressor base by means of a four point, heavy-duty isolation system for a minimum of 95% isolation efficiency. System shall be engineered for equal weight distribution between four isolation points.

D. Flexible connections between compressor units and the structure shall be provided for all outlets. Inlet flexes are corrugated metal with outer stainless braid. Outlet flexes are metal and double wall with thermal isolation.

E. Compressors shall be a continuous duty rated scroll type. The design shall be single stage, air-cooled, consisting of one fixed and one orbiting scroll sealed with PTFE tip seals between the scroll halves and rated for 828 kPa (120 PSIG) discharge pressure. Orbiting bearings shall be grease filled. Compressors shall be field serviceable for tip seal change and bearing lubrication. Non-field serviceable scroll compressors are not acceptable. Noise level shall not exceed 75 dB(A) for duplex system, 78 dB(A) for triplex

system, and 80 dB(A) for quad system with pumps running at peak demand. Belt tensioning shall be achieved with a sliding motor mounting base adjustable with two tensioning screws. Each compressor unit shall be equipped with a distinct after cooler with separate cooling fan designed for a maximum approach temperature of 7°C (15°F) at 37.8°C (100°F) ambient and complete with electronic drain valve. The discharge of piping of each compressor shall incorporate an electronic solenoid valve to prevent reverse rotation of the scroll at shutdown.

F. Control system in contained in a cabinet factory pre-punched for conduit connections. Provide three punches: for power in sized per NFPA 70 Article 310 and based on total system amperes, for communications and for master alarm wiring, each sized for ½" EMT conduit. The control system shall be built and labeled in a UL approved panel shop operating under ISO 13485 Medical Device registration. The control panel shall have a SCCR Rating of 65K amperes RMS. Provide in the control system door:
1. 16 bit, full color, VGA resolution touch screen display for system functions and system level control
2. Separate 16 bit, full color half VGA resolution touch screen for display of compressor unit functions and compressor unit control. These controls provide selector control of Automatic, Manual (continuous run) or Off for each compressor unit.
3. Screens shall turn off when not in use to preserve screen life.
4. A separate disconnect handle with door interlock for each compressor unit.
5. Audio sounder capable of 80 dB at 3 feet with mute function provided by the controls.
6. Power on lamp illuminated whenever any disconnect is On.
7. Means for automatically deactivating the screen saving function.

G. Provide in the control cabinet interior:
1. Full voltage motor starters with overload protection, one per compressor unit.
2. Circuit breaker disconnects, one for each compressor unit operated by the through the door disconnect handle.
3. Redundant 24 Volt DC control circuit transformers including power seeking function in the event one power supply fails.
4. Power distribution terminal block convenient for main power entry.
5. All internal circuit boards and components needed for operation of the control system as described below.
6. Volt free contacts for connection to master alarms.
7. Controls circuitry shall be 24 Volts DC for worker safety. No system component other than the drive motors shall require greater than 24V for operation.

H. The control system shall provide for the following functionality:
1. Display of pressure and dewpoint on a single display for at a glance checking.
2. Automatic lead/lag sequencing and alternation. Display clearly shows status of each compressor unit including running unit, next-unit-in-sequence, and units unavailable to run.
3. Runtime hour-meters for each compressor unit.
4. In the event of control failure the system shall activate all alarms and operate on a simple on/off basis until repaired.
5. When H-O-M selectors are in Manual mode, system will operate on pressure switch and compressor units will not run if lead switch is satisfied.
6. Visual and audible alarm indication and isolated contacts for remote alarm for at least High Dew Point and High Temperature for each compressor unit alone or system together and critical maintenance issues.
7. Continuous monitoring of ambient temperature.

8. Automatic indication of major maintenance intervals and details of required maintenance kits.
9. Distinct separate indication on the control screens of alarms which shutdown the compressor vs. alarms which do not shut down the compressor vs. maintenance notifications.
10. Isolated contacts for remote alarms which can distinguish between a condition which shuts down the unit, A condition which does not shut down the system and A maintenance alert.
11. Permit individual test of high dew point, high temperature and controls fault alarm points from the touchscreen. System shall include low level testing of controls, local and connected master (source) alarms.
12. One-person “bumping” of the compressors to test rotation.
13. Logs and allows review of all alarm and shutdown events.
14. Logs and allows review of all maintenance events.
15. Control system is highly redundant. Control systems which can lose any single component and fail to make air are not acceptable.

I. Compressor motors shall be a NEMA Premium Efficiency rated, open drip proof unit with 1.15 service factor suitable for 208 or 230/460 volt, three phase, 60hz.

J. All moving parts (fans, pulleys and belts) shall be fully protected by OSHA acceptable enclosures and guards.

K. Provide temperature sensor at the outlet of each compressor cylinder or air-end to provide high temperature alarm and shutdown that compressor.

L. Provide two redundant lab air treatment systems consisting of desiccant dryers and filters sized for all three compressors output combined. Lab air treatment shall include:
1. Desiccant dryers producing a -40°F pressure dew point.
2. Dryer purge flow control through an integral PDP sensor purge control system.
3. Mounted coalescing pre-filter rated for 0.01 micron with automatic drain and element change indicator at the inlet to each dryer.
4. Final line filters rated for 0.1 micron with element change
5. Final line regulators.

M. System piping is welded except where unions are required for service or where piping connects to valves or system components. Main flow path joints are flanged and provided with seals, use 37° SAE flares suitable for flare-tight seals or SAE straight thread with O-ring seal for leak tight connection and ease of replacement or service.

N. Provide corrosion resistant, powder coated, ASME Coded, National Board Certified receiver rated for a minimum 150 PSIG design pressure. Include a liquid level glass with bead, safety relief valve, manual drain valve, and zero loss tank drain

O. The complete lab air system and all electrical components shall be factory pretested prior to shipment by the manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Prepare soldered joints in accordance with ASTM B828.

B. Ream pipe and tube ends. Remove burrs.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment with flanges or unions.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.4 INSTALLATION - HANGERS AND SUPPORTS

A. Install hangers and supports in accordance with MSS SP 69.

B. Support horizontal piping [in accordance with NFPA 99 and as scheduled in this section.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every floor; maximum 15 feet on center. Support riser piping independently of connected horizontal piping.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.5 INSTALLATION - BURIED PIPING SYSTEMS

A. Establish elevations of buried piping with not less than 4 ft of cover.

B. Excavate pipe trench in accordance with Division 31.

C. Install buried oxygen piping in protector piping.

D. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth in accordance with Division 31.

E. Install pipe on prepared bedding.

F. Route pipe in straight line.

G. Install pipe to allow for expansion and contraction without stressing pipe or joints.

H. Install plastic ribbon tape continuous over top of pipe.

I. Pipe Cover and Backfilling:
1. Backfill trench in accordance with Division 31.
2. Maintain optimum moisture content of fill material to attain required compaction density.
3. After pressure test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 4’ minimum cover over top of pipe.
4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.

3.6 INSTALLATION - ABOVE GROUND PIPING - MEDICAL GAS SYSTEMS

A. Install medical gas systems in accordance with NFPA 99.

B. Install pressure relief piping with termination exterior to building with elbow turned down. After elbow increase one pipe size and terminate with galvanized steel attached to a threaded section of piping. Terminate 25’ from air intakes.

C. Install vacuum pump exhaust with termination exterior to building with elbow turned down. After elbow increase one pipe size and terminate with galvanized steel attached to a threaded section of piping. Terminate 25’ from air intakes.

D. Install air intake for medical air equipment and compressed air equipment with termination exterior to building with elbow turned down. After elbow increase one pipe size and terminate with galvanized steel attached to a threaded section of piping. Terminate 25’ from exhaust air intakes, Terminate medical air intake minimum 20’ above grade.

E. During brazing of pipe connections, purge interior of pipe continuously with nitrogen.

F. Cut pipe and tubing accurately and install without springing or forcing.

G. Slope piping in direction of flow.

H. Make branch connections in accordance with NFPA 99.

I. Pressure Gages:
1. Install at locations identified in NFPA 99.
2. Install capable of being read from standing position.
3. Install pressure gages located downstream from source valve with demand check fitting.

J. Install pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions.

K. Coordinate with firestopping requirements. Refer to Division 7.

L. Install pipe identification in accordance with this Section.

M. Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.

N. Install locks on valves.

3.7 INSTALLATION - EQUIPMENT

A. Install medical gas system equipment in accordance with NFPA 99.

B. Install equipment on concrete housekeeping pads, minimum 3-1/2 inches high and 6 inches larger than equipment base on each side. Refer to Division 3 and Section 22 05 48.

C. Connect equipment to piping with flexible piping connections.

D. Install condensate drain piping to nearest floor drain.

E. Install components furnished loose for field mounting.

F. Install electrical devices furnished loose for field mounting.

G. Install control wiring between equipment and field installed accessories.

H. Make connections to equipment with unions or flanges.

I. Install valves and piping specialties as indicated on Drawings.

J. Installation - Gas Cylinder Manifolds:
1. Install relief valve between final pressure regulator and source valve.
2. Install relief valve vent piping to building exterior, sized at least full size of relief valve outlet.
3. Extend relief valve vent piping minimum of 6 feet above pedestrian areas.
4. Install discharge turned down and with screen at outlet.

3.8 LABELING AND IDENTIFICATION

A. Piping:
1. Install pipe labels at intervals of not more than 20 feet.
2. Install minimum of one pipe label in each room.
3. Install label on each side of wall when penetrated by piping.
4. Risers: Install minimum of one label for each story traversed by piping.

B. Label gas cylinders with either labels or stencils naming contents in accordance with CGA C-7.

3.9 FIELD QUALITY CONTROL

A. Division 01 - Field inspecting, testing, adjusting, and balancing.

B. Installer Performed Tests - Level 1 and Level 2 Systems:
1. Perform the following installer performed tests in accordance with procedures specified in NFPA 99:
a. Initial blow down.
b. Initial pressure test.
c. Cross connection test.
d. Piping purge test.
e. Standing pressure test for positive pressure medical gas systems.
f. Standing pressure test for vacuum systems.

C. System Verification Tests - Level 1 and Level 2 Systems:
1. Perform after completion of Installer Performed Tests.
2. Conduct test by agency independent of system installer.
3. Perform the following system verification tests in accordance with procedures specified in NFPA 99:
a. Standing pressure test.
b. Cross connection test.
c. Individual system pressurization.
d. Valve test.
e. Alarm test.
f. Piping purge test.
g. Piping particulate test.
h. Piping purity test.
i. Final tie-in test.
j. Operational pressure test.
k. Medical gas concentration test.
l. Medical air purity test.
m. Labeling verification.
n. Source equipment verification:
1) Gas supply sources.
2) Medical air compressor system.
3) Medical-surgical vacuum systems.

3.10 MANUFACTURER'S FIELD SERVICES

A. Division 01 - Quality Requirements: Requirements for manufacturer’s field services.

B. Furnish services of factory trained representative to start-up equipment and calibrate controls.

3.11 DEMONSTRATION

A. Division 01 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate each piece of equipment operation and maintenance.

C. Furnish services of manufacturer's technical representative for 8 hours to instruct Owner's personnel in operation and maintenance of medical gas equipment and accessories

3.12 SCHEDULES

A. Pipe Hanger Spacing:

PIPE HANGER SPACING		
PIPE SIZE Inches	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
1/4 (8)	5	3/8
3/8 (10)	6	3/8
1/2	6	3/8
3/4	7	3/8
1	8	3/8
1-1/4	9	3/8
1-1/2 and Larger	10	3/8

END OF SECTION

SECTION 230400

GENERAL CONDITIONS FOR MECHANICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to all Divisions 23 Sections.

B. This section applies to certain sections of Division 26, "Electrical," and this section applies to all sections of Division 23, "Mechanical" of this project specification unless specified otherwise in the individual sections.

C. The Drawings of other trades (Architectural, Food Service, Structural, Landscape, Civil, Mechanical, Fire Protection and Plumbing) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

1.2 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

1.3 INTENT

A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation. Provide all parts necessary for the intended use, fully complete and operational, and installed in professional manner in accordance with the design intent.

B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.

C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.

D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.4 DEFINITIONS

A. No Exceptions Taken – reviewed and determined to be in general conformance with contract documents.

B. “Approved equal” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

D. “Finished” refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

E. “Furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.

F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

G. “Install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.

H. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

I. “Provide” shall mean furnish (or supply) and install as necessary.

J. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

K. Remove: The term “remove” means “to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”

L. Special Warranties: The term “Special Warranties” are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

M. Standard Product Warranties: The term “Standard Product Warranties” are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

N. “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.

O. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."

P. “Wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

1.5 CONTRACT DOCUMENTS

A. The two dimensional drawings govern the construction. They show the design intent and are part of the Contract Documents. BIM models are not part of contract documents. They are developed for convenience only.

B. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

C. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

D. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.

1.6 DISCREPANCIES IN DOCUMENTS

A. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

B. Where Drawings or Specifications conflict or are unclear, submit clarification request in writing before Award of Contract. Otherwise, Architect's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or un-clarities thus resolved.

C. Where Drawings or Specifications do not coincide with manufacturers' recommendations or with applicable codes and standards, submit clarification request in form of an RFI before installation. Otherwise, make changes in installed work required for compliance with manufacturer instructions or codes and standards within Contract Price.

D. Where insufficient information exists in the documents to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements, where notification required by Paragraph (B) above has not been submitted, provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in professional manner either concealed or exposed in accordance with the design intent.

E. Where discrepancies exist between the mechanical, plumbing, fire protection, and electrical drawings in regards to what trade owns disconnects or starters, the discrepancy shall be brought to the Architect's attention in accordance with paragraph (B) above. If the scope is not resolved prior to the Award of Contract, Division 26 shall provide such items.

1.7 CODES AND STANDARDS

A. Reference Standard Compliance
1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

B. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision of the local building or life safety code shall be followed.

C. The following Standards shall be used where referenced by the following abbreviations:

AABC	Associated Air Balance Council
ACGIH	American Conference of Governmental Industrial Hygienists
ADC	Air Diffusion Council
AGA	American Gas Association
AIA	American Institute of Architects
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers

ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CGA	Compressed Gas Association
CSA	Canadian Standards Association
CISPI	Cast Iron Soil Pipe Institute
EJMA	Expansion Joint Manufacturing Association
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
HIS	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	Insurance Services Office
MCAA	Mechanical Contractors Association of America
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOFI	National Oil Fuel Institute
NSC	National Safety Council
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SBI	Steel Boiler Industry (Division of Hydronics Institute)
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
STI	Steel Tank Institute
UL	Underwriters' Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.8 PERMITS AND FEES

A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.9 EQUIPMENT EQUIVALENTS AND SUBSTITUTIONS

A. Certain manufacturers of material, apparatus or appliances are indicated in the drawings and specifications for this project. These items have been used as the basis of design, and as a convenience in fixing the minimum standard of quality, finish and design that is required. If the Contractors uses an “approved equal” alternative to the basis of design, and if the features of that alternative have an impact on other components of the Project, the Contractor shall include the necessary adjustments in those components, whether for architectural, structural, mechanical, electrical, fire protection, or any other elements, plus any adjustments for difference in performance.

B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for Architect and Engineer review.

C. Where the Contractor proposes to use an item that is different from the basis of design in the Drawings and specifications, and that will require the redesign of the structure, partitions, foundations, piping, wiring or any other component of the mechanical, electrical, or architectural layout, the Contractor shall provide the necessary redesign of those components.

D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the basis of design scheduled equipment or materials as hereinafter specified or shown on the drawings, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution, equivalent or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

E. If an alternative or substitute item results in a difference in quantity and arrangement of structure, piping, ductwork, valves, pumps, insulation, wiring, conduit, and equipment from that specified or indicated on the Drawings, the Contractor shall furnish and install any such additional equipment required by the system, at no additional cost to the Owner

including any costs added to other trades due to the equivalent change from the basis of design detailed in the drawings or included within the specifications.

F. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:

G. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.

H. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:

a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
b. Samples, where applicable or requested.
c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
f. Cost information, including a proposal of the net change, if any in the Contract Sum.
g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
    1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.

2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.10 SUBMITTAL PROCEDURES

A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
1. Allow ten business days for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
2. If an intermediate submittal is necessary, process the same as the initial submittal.
3. Allow ten business days for reprocessing each submittal.
4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
1. Include the following information on the label for processing and recording action taken.
   a. Project name.
   b. Date.
   c. Name and address of Engineer.
   d. Name and address of Contractor.
   e. Name and address of subcontractor.
   f. Name and address of supplier.

g. Name of manufacturer.
h. Number, title and paragraph of appropriate Specification Section.
i. Drawing number and detail references, as appropriate.

E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.

G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

H. LEED Submittals: Provide manufacturers' or third-party certification of testing to and compliance with the California Department of Public Health (CDPH) Standard method v1.2-2017, that includes the following information:
1. The exposure scenario used to determine compliance.
2. The range of total VOCs after 14 days, measured as specified in the CDPH Standard Method v1.2:
3. 0.5 mg/m^3 or less;
4. Between 0.5 and 5.0 mg/m^3; or
5. 5.0 mg/m^3 or more
6. Laboratory accreditation under ISO/IEC 17025.
7. Claims of compliance for wet-applied products must state the amount applied in mass per surface area
8. Provide MSDS or other manufacturer documentation with disclosure of VOC content for all wet-applied products.
9. Complete "LEED Materials Documentation Sheet" with IEQc2 information for adhesives/sealants installed within the waterproofing membrane.

1.11 SHOP DRAWINGS

A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review all shop drawings to be incorporated in the Mechanical Contract.

C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.

E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.

G. "No Exception Taken" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.

H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.

I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.

J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.

K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

L. All submittals shall be made in electronic PDF format with searchable OCR (Optical Character Recognition) format. This excludes scanned and faxed materials.

1.12 COORDINATION DRAWINGS AND BIM MODEL

A. Coordination drawings are required for all mechanical and electrical trades. The content and procedures described in Division 01 shall be followed, with the additional requirements specifically for the mechanical and electrical trades as described in this Section. If a BIM model is not used on this project, the below requirements shall be accomplished in CAD.

B. Prepare coordination drawings accordance with Division 1, at 1 to 1 (full) scale prepared at ¼" = 1' -0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
      a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
      b. Equipment connections and support details.
      c. Exterior wall and foundation penetrations.
      d. Fire-rated wall and floor penetrations.
      e. Sizes and locations of required concrete pads and bases.

C. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

D. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

E. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

F. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.

G. Work shall not be performed until coordination drawings have been approved by the architect and engineer.

H. Electronic copies of the MEP floor plans and/or BIM model are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. If the Contractor elects to obtain the Engineers electronic files an Electronic Drawing File Release Form must be submitted. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic Drawing File Release Form, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the Electronic Drawing File Release Form is appended to the end of this specification section

I. Review by Engineer of coordination drawings is limited to confirming that requirements for coordination and preparation of plans have been complied with by the Contractor and shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with Architectural, Structural, Mechanical, Electrical and other related work.

1.13 COORDINATION WITH OTHER DIVISIONS

A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as

to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.

B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.

C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.

D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

E. The two dimensional drawings are diagrammatic. They indicate general arrangements of mechanical systems and other work, and are intended to convey sufficient information for skilled contractors and tradespeople to furnish and install complete systems. They are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, provide all other components and materials to make the systems fully complete, coordinated with other systems and the structure and space available, and operational. Similarly, the drawings do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades in order to avoid interferences and to meet ceiling heights and other Architectural requirements. Establish and provide offsets, changes in direction, and exact routings to coordinate all systems. Where conflicts or potential conflicts exist and engineering guidance is desired, submit a “Request for Information” (RFI).

F. Controls contractor shall coordinate and sequences of operation with all other trades as necessary to provide a complete and functioning system.

1.14 QUALITY CONTROL

A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled tradespeople, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

E. All labor for installation of mechanical systems shall be performed by experienced, skilled tradespeople under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, professional manner. The Engineer reserves the right to reject any work which, in their opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

F. LEED Requirements:
1. For field applications that are inside the weatherproofing membrane: Adhesives/sealants must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario. The default scenario is the private office scenario.
2. All adhesives/sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.

1.15 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.

B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.16 TEMPORARY UTILITIES

A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. First Aid Supplies: Comply with governing regulations.

D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.

E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.

1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.

F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.

G. Temporary Heat-Cool-Dehumidification: Provide temporary services required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate temporary services to produce the ambient condition required and minimize consumption of energy. The building’s permanent HVAC systems shall not be used for these purposes.

H. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

I. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.17 Equipment Access

A. Appliances, controls devices, heat exchangers and HVAC system components that utilize energy shall be accessible for inspection, service, repair and replacement without disabling the function of a fire-resistance-rated assembly or removing permanent construction, other appliances, venting systems or any other piping or ducts not connected to the *appliance* being inspected, serviced, repaired or replaced. A level working space not less than 30 inches deep and 30 inches wide (762 mm by 762 mm) shall be provided in front of the control side to service an *appliance*.

1.18 PROTECTION OF MATERIALS AND EQUIPMENT

A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workpeople and shall include making good all damage thus caused.

B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by tradespeople or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.19 ADJUSTING AND TESTING

A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.

B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing that the equipment was installed according to manufacturer’s recommendations and is operating as intended by the manufacturer.

1.20 CLEANING

A. The Contractor shall thoroughly clean and flush all piping, ducts and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.

B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

C. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.

D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
1. Remove labels that are not permanent labels.
2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.

F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.

G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.21 OPERATING AND MAINTENANCE

A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, the contractor shall fully instruct the Owner or the Owner’s representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

D. An authorized manufacturer’s representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.

E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

F. Demonstration shall be recorded on USB Flash drive turned over to the Owner. Video recording shall be done in a professional manner with quality video (1080p resolution) and clear audible sound.

1.22 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare up to six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.

B. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing and operating instructions including lubrication charts and schedules.
5. Emergency and safety instructions.
6. Spare parts list.
7. Copies of warranties.
8. Wiring diagrams.
9. Recommended "turn around" cycles.
10. Inspection procedures.
11. Approved Shop Drawings and Product Data.
12. Equipment Start-up Reports.
13. Temperature control diagrams and written sequences of operations.
14. Balance reports.

C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.

D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.23 ACCEPTANCES

A. The equipment, materials, quality, design and arrangement of all work installed under the Mechanical Sections shall be subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, the Mechanical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work

under the Mechanical Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.

C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner's representative.

D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Mechanical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.

F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.24 RECORD DRAWINGS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
1. Dimensional change
2. Revision to drawing detail
3. Location and depth of underground utility
4. Revision to pipe routing
5. Revision to electrical circuitry
6. Actual equipment location
7. Duct size and routing
8. Location of concealed internal utility
9. Changes made by Change Order
10. Details not on original Contract Drawing
11. Information on concealed elements which would be difficult to identify or measure later

C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.

D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.

E. Note related Change Order numbers where applicable.

F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

G. Final record documents shall be prepared in the latest electronic version and on USB Flash drive of all drawings and a clean set of reproducible paper copies shall be turned over to the Owner at the completion of the work.

1.25 WARRANTIES AND BONDS

A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
   1. General close-out requirements included in Division 1.
   2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions-2 through -50.
   3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.26 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
   1. Refer to individual Sections of Divisions-2 through -50 for specific content requirements, and particular requirements for submittal of special warranties.

J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
   1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
   2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
   3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.27 GUARANTEES

A. The Contractor shall guarantee all material and installation quality under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or installation quality shall be corrected or replaced

immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

1.28 PROJECT CLOSE-OUT

A. Submit specific warranties, quality bonds, maintenance agreements, final certifications and similar documents in accordance with Division 1.

B. Deliver tools, spare parts, extra stock, and similar items.

C. Complete start-up testing of systems, including measuring and documenting all required startup checklist requirements documented in installation and maintenance instructions by the equipment manufacturer, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

D. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

E. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued. Contractor shall submit written response to each corrective item including specific photos prior to final Engineering inspection.
   1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
   2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION

Electronic Drawing File Release Form

DELIVERY OF FILES FOR: _____

Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ _____
Client's Signature Date

_____
Company - Title

_____ _____
Architects' Signature Date

_____
Firm - Title

_____ _____
Owner's Signature Date

_____
Company - Title

SECTION 230516

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Design of expansion systems and anchors

B. Flexible pipe connectors.

C. Expansion joints and compensators.

D. Pipe Alignment Guides

E. Swivel Joints

F. Pipe Anchors

1.2 RELATED REQUIREMENTS

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 specifications

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

B. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Inch Standard.

C. ASME B16.11 - Forged Fittings, Socket-welding and Threaded.

D. ASME B31.9 – Building Services Piping

E. ASME Section IX – Boiler and Pressure Vessel Code- Welding and Brazing Qualifications.

F. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

G. AWS D1.1 – Structural Welding Code- Steel.

H. EJMA (STDS) - EJMA Standards.

I. FM (AG) - FM Approval Guide.

J. ITS (DIR) - Directory of Listed Products.

K. UL (DIR) - Online Certifications Directory.

1.4 DESIGN REQUIREMENTS

A. Provide design, details, work and equipment required for expansion and contraction of hot water and steam piping systems. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

C. Expansion Compensation Design Criteria:
1. Installation Temperature: 50°F.
2. Hot Water Heating System Temperature: 210°F.
3. Refrigerant System Temperature: Refer to manufacturers design literature.
4. Safety Factor: 30%.

1.5 SUBMITTALS

A. Pipe Expansion Analysis, Design and Certification:
1. Provide pipe expansion and anchoring calculations for all refrigerant, steam and hot water piping systems including connections to equipment and to the structure. Piping layouts and associated calculations must be stamped by a registered professional engineer with at least five years of pipe expansion experience, licensed in the state of the job location.
2. Analysis must indicate calculated dead loads, active expansion loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/ or welded length. All expansion and anchoring devices shall be designed to accept the forces as calculated.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Indicate installed locations of flexible pipe connectors, expansion joints, anchors and guides.

C. Product Data:
1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.

E. Maintenance Data: Include adjustment instructions.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Extra Packing for Packed Expansion Joints: One set for each joint.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years' experience.

B. Installer: Company specializing in performing work of this section with minimum five years' experience.

C. Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licensed in state which the work will occur.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Mason Industries

B. The Metraflex Company

C. UniSource Manufacturing

2.2 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

A. Inner Hose: Bronze.

B. Exterior Sleeve: Single braided, stainless steel.

C. Pressure & Temperature Rating: 125 psi and 450°F.

D. Joint: Flanged.

E. Size: Use pipe sized units.

F. Maximum offset: 3/4 inch on each side of installed center line.

2.3 FLEXIBLE PIPE CONNECTORS - COPPER PIPING SERVING WATER SYSTEMS

A. Inner Hose: Bronze.

B. Exterior Sleeve: Braided bronze.

C. Pressure & Temperature Rating: 125 psi and 450°F.

D. Joint: Flanged.

E. Size: Use pipe sized units.

F. Maximum offset: 3/4 inch on each side of installed center line.

G. Application: Copper piping serving water-based systems.

2.4 FLEXIBLE PIPE CONNECTORS - COPPER PIPING SERVING REFRIGERANT SYSTEMS

A. Inner Hose: Stainless Steel.

B. Exterior Sleeve: Braided 304 Stainless Steel

C. Pressure Rating: 650 psi.

D. Joint: Brazed.

E. Size: Use pipe sized units.

F. Maximum offset: 3/4 inch on each side of installed center line.

G. Application: Refrigerant Piping.

H. Certifications: UL Listed for Refrigeration Service.

2.5 EXPANSION JOINTS - STAINLESS STEEL BELLOWS TYPE

A. Pressure & Temperature Rating: 125 psi and 400°F.

B. Maximum Compression: 1-3/4 inches.

C. Maximum Extension: 1/4 inch.

D. Joint: Flanged.

E. Size: Use pipe sized units.

F. Application: Steel piping 3 inches and under.

2.6 EXPANSION JOINTS - STEEL WITH PACKED SLIDING SLEEVE

A. Working Pressure and Temperature: Class 150.

B. Joint: Flanged.

C. Size: Use pipe sized units.

D. Application: Steel piping 2 inches and over.

2.7 EXPANSION JOINTS - COPPER WITH PACKED SLIDING SLEEVE

A. Working Pressure: 125 psi.

B. Maximum Temperature: 250°F.

C. Joint: Flanged.

D. Size: Use pipe sized units.

E. Application: Copper or steel piping 2 inches and over.

2.8 EXPANSION **LOOPS** - HOSE AND BRAID

A. Provide flexible loops with two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return with support bracket and air release or drain plug.

B. Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.

C. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
1. Maximum Allowable Working Pressure & Temperature: 150 psig at 120°F.
2. Accommodate the Following:
   a. Axial Deflection in Compression and Expansion: To be determined by the Professional Engineer providing calculations.
   b. Lateral Movement: To be determined by the Professional Engineer providing calculations.
   c. Angular Rotation: 15 degrees.
   d. Force developed by 1.5 times specified maximum allowable operating pressure.
3. End Connections: Same as specified for pipe jointing.
4. End Connections: Flanged ductile iron; complying with ASME B16.1 Class 125.
5. End Connections: Threaded; complying with ASME B16.11.
6. Provide necessary accessories including, but not limited to, swivel joints.

2.9 PIPE ALIGNMENT GUIDES

A. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel

2.10 SWIVEL JOINTS

A. Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

2.11 PIPE ANCHORS

A. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 PSI and the design shall be balanced for equal resistance in any direction.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.

C. Install flexible pipe connectors on:

1. Pipes connected to pumps.
2. Refrigerant piping connections to equipment per recommendations of equipment manufacturer.
3. Pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

E. Rigidly anchor pipe to building structure. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

F. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

G. For systems using grooved piping systems, provide with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation.

H. Provide piping expansion loops at all building expansion joints as indicated on drawings.

I. Provide piping expansion joints or expansion loops as indicated below:
1. Provide and install pipe expansion joints or expansion loops at all conditions listed below and as required to minimize stress on the piping systems.
2. Provide pipe guides at inlet and outlet of each expansion joint and expansion loop.
3. Where expansion joints or loops are required, provide pipe anchors at ends of each straight length of run.
4. Provide and install expansion joints, expansion loops, pipe guides and anchors per ASHRAE guidelines and manufacturer’s recommendations.

PIPING SYSTEM	PIPING MATERIAL	PIPE SIZE	Condition Requiring expansion joint or expansion loop (all conditions assume “offset leg” at end of runs are minimum 12’0” long)
Hot water supply and return (all temperatures)	Copper	Up to 3 inches	All straight sections of piping over 90’ long. All straight sections of piping where “offset leg” is less than 12’0”
Hot water supply and return (all temperatures)	Steel	Up to 2 inches	All straight sections of piping over 140’ long.
Hot water supply and return (all temperatures)	Steel	2” to 4”	All straight sections of piping over 90’ long
Hot water supply and return (all temperatures)	Steel	5” to 8”	All straight sections of piping over 45’ long
Chilled water supply and return (all temperatures)	Steel	2” to 4”	All straight sections of piping over 200’ long
Chilled water supply and return (all temperatures)	Steel	5” to 8”	All straight sections of piping over 100’ long

END OF SECTION

SECTION 230517

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe sleeves.

B. Manufactured sleeve-seal systems.

1.2 RELATED REQUIREMENTS

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

B. Division 07 – Thermal and Moisture Protection.

C. Division 09 - Finishes.

D. Section 23 0523 - General-Duty Valves for HVAC Piping.

E. Section 23 0553 - Identification for HVAC Piping and Equipment: Piping identification.

F. Section 23 0716 - HVAC Equipment Insulation.

G. Section 23 0719 - HVAC Piping Insulation.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).

B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

1.4 SUBMITTALS

A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Extra Valve Stem Packings: Two for each type and size of valve.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified this section.

1. Minimum three years experience.
2. Approved by manufacturer.

C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

1.7 WARRANTY

A. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 PIPE SLEEVES

A. Materials
1. Galvanized-Steel Sheet: 0.0239-inch 0.6-mm minimum thickness; round tube closed with longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2.2 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. Flexicraft Industries; PipeSeal.
2. Metraflex
3. Link-Seal
4. Substitutions: See Division - 01 General Requirements.

B. Modular/Mechanical Seal:
1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.1 GENERAL

A. Lay out penetration and sleeve openings in advance, to permit provision in work. Coordinate work with architectural and structural work. Set sleeves and conduit in forms before concrete is poured. Provide remedial work where sleeves and conduits are omitted or improperly placed. Remedial work includes core drilling (see requirements below) for penetrations if walls are poured, or otherwise constructed, without required

sleeves. Provide core drilling (see requirements below) of existing construction. Do not penetrate structural members without Structural Engineer's/Architect's written approval.

B. Sleeve installation shall meet NFPA-101 requirements, UL rated assemblies requirements, and materials requirements of these specifications. Submit a list of the UL listed details that the Contractor intends on using on this project in all rated assemblies.

C. Sleeves that penetrate outside walls, basement slabs, footings and beams shall be waterproof. Sleeves that penetrate floors shall be fireproof and waterproof.

D. Identify unused sleeves and slots for future installation. Fill slots, sleeves and other openings in floors or walls if not used. Fill spaces in openings after installation of pipe, duct, conduit or cable. Fill for floor penetrations shall prevent passage of water, smoke, fire, and fumes. Fill shall be fire resistant in fire floors and walls, and shall prevent passage of air, smoke and fumes.

E. Do not support piping risers or conduit on sleeves.

F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 for materials.

G. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements. Verify final equipment locations for roughing-in.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

3.3 APPLICATIONS

A. Provide sleeves when penetrating footings, floors, walls, partitions, and other building components as follows:
   1. Interior walls, partitions, and floors: galvanized-steel sheet, unless steel or brass sleeves are specified elsewhere.
   2. Below Grade Exterior Walls: Zinc coated or cast iron pipe with mechanical sleeve seals. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
   3. Above Grade Exterior Walls: steel pipe sleeve with mechanical sleeve seals.
   4. Mechanical, Laundry, and Animal Room Floors above Basement: Galvanized steel pipe or black iron pipe with asphalt coating. Connect sleeve with floor plate except in mechanical rooms.
   5. Concrete and masonry walls, concrete floor and roof slabs: galvanized-steel sheet
   6. Floors with membrane waterproofing: stack sleeve fittings

3.4 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

B. Install piping to conserve building space, to not interfere with use of space and other work.

C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Install sleeves that are large enough to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation. Sleeves for insulated pipe and duct in non-fire rated construction shall accommodate continuous insulation without compression. Sleeves and/or penetrations in fire rated construction shall be packed with fire rated material that shall maintain the fire rating of the wall. Seal ends of penetrations to provide continuous vapor barrier where insulation is interrupted.

E. Where pipes passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.

F. Inserts:
1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

G. Structural Considerations:
1. Do not penetrate building structural members unless indicated.

H. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
1. Underground Piping: Mechanically expandable chloroprene inserts with bitumen sealed metal components.
2. Aboveground Piping:
   a. Pack solid using mineral fiber conforming to ASTM C592.
   b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
3. All Rated Openings: Caulk tight with fire stopping material conforming to ASTM E814 in accordance with Division 07 to prevent the spread of fire, smoke, and gases.
4. Caulk exterior wall sleeves watertight with Mechanically expandable chloroprene inserts with mastic-sealed components.

I. Vertical Piping:
1. Sleeve Length: 1 inch above finished floor.
2. Provide sealant for watertight joint.

3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

J. Clearances:
1. Provide allowance for insulated piping.
2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
3. All Rated Openings: Caulked tight with fire stopping material conforming to ASTM E814 in accordance with Division 07 to prevent the spread of fire, smoke, and gases.

K. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.
6. Install in accordance with manufacturer's recommendations.

L. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.5 CORE DRILLING

A. Core drilling shall be avoided in new construction. Set sleeves prior to installation of structure for passage of pipes, conduit and ducts. Where core drilling is unavoidable (e.g. when individual sleeves are not installed or incorrectly located) or required by renovation projects, locate required openings prior to coring and submit locations for review.

B. Coordinate openings with other Divisions.

C. Do not disturb existing systems. Protect areas from damage.

D. Thoroughly investigate existing conditions in vicinity of required opening prior to coring.

3.6 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

SECTION 230523

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Applications.

B. General requirements.

C. Angle valves.

D. Globe valves.

E. Ball valves.

F. Butterfly valves.

G. Check valves.

H. Gate valves.

I. Plug valves.

J. Chainwheels.

1.2 ABBREVIATIONS AND ACRONYMS

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. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. SWP: Steam working pressure.

I. TFE: Tetrafluoroethylene.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. API STD 594 - Check Valves: Flanged, Lug Wafer, and Butt-Welding.

B. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250;.

D. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.

E. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.

F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

G. ASME B16.34 - Valves - Flanged, Threaded and Welding End.

H. ASME B31.1 - Power Piping.

I. ASME B31.9 - Building Services Piping.

J. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications.

K. ASTM A48/A48M - Standard Specification for Gray Iron Castings.

L. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

M. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.

N. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

O. ASTM A536 - Standard Specification for Ductile Iron Castings.

P. ASTM A582/A582M - Standard Specification for Free-Machining Stainless Steel Bars;.

Q. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings.

R. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

S. AWWA C606 - Grooved and Shouldered Joints.

T. MSS SP-45 - Bypass and Drain Connections.

U. MSS SP-67 - Butterfly Valves.

V. MSS SP-68 - High Pressure Butterfly Valves with Offset Design.

W. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.

X. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.

Y. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.

Z. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.

AA. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

BB. MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends.

CC. MSS SP-108 - Resilient-Seated Cast Iron Eccentric Plug Valves.

DD. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

EE. MSS SP-125 - Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves.

1.4 SUBMITTALS

A. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

B. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

C. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

1.5 QUALITY ASSURANCE

A. Manufacturer:
1. Obtain valves for each valve type from single manufacturer.
2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

B. Welding Materials and Procedures: Conform to ASME BPVC-IX.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
2. Protect valve parts exposed to piped medium against rust and corrosion.
3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
5. Secure check valves in either the closed position or open position.
6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.
      b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:
   1. Handle large valves with sling, modified to avoid damage to exposed parts.
   2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.1 GENERAL

A. See Drawings for specific valve locations.

B. Refer to Part 3 for applications.

C. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

2.2 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
   2. Handwheel: Valves other than quarter-turn types.
   3. Hand Lever: Quarter-turn valves 6 NPS and smaller except plug valves.
   4. Wrench: Plug valves with square heads.
   5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: Provide 2 inch stem extensions and the following features:
   1. Gate Valves: Rising stem.
   2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   3. Butterfly Valves: Extended neck.
   4. Memory Stops: Fully adjustable after insulation is installed.

E. Memory Stops: Fully adjustable after insulation is installed.

F. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.
5. Grooved End Connections: AWWA C606.

G. General ASME Compliance:
1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
2. Power Piping Valves: ASME B31.1.
3. Building Services Piping Valves: ASME B31.9.

H. Bronze Valves:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Source Limitations: Obtain each valve type from a single manufacturer.

2.3 BRONZE GLOBE VALVES

A. Class 125: CWP Rating: 200 psig:.
1. Comply with MSS SP-80, Type 1.
2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
3. Ends: Threaded or solder joint.
4. Stem and Disc: Bronze or PTFE
5. Packing: Asbestos free.
6. Handwheel: Malleable iron or bronze.
7. Manufacturers:
a. Nibco Inc.
b. Grinnell
c. Crane Co.
d. Milwaukee Valve Co.

2.4 IRON GLOBE VALVES

A. Class 125: CWP Rating: 200 psig:, and Class 250: CWP Rating: 500 psig:.
1. Comply with MSS SP-85, Type I.
2. Body: Gray iron; ASTM A126, with bolted bonnet.
3. Ends: Flanged.
4. Trim: Bronze.
5. Packing and Gasket: Asbestos free.
6. Operator: Handwheel or chainwheel.
7. Manufacturers:
a. Nibco Inc.
b. Grinnell
c. Crane Co.
d. Milwaukee Valve Co.

2.5 BRASS BALL VALVES

A. Two Piece, Full Port, Ball Valves with Stainless Steel Trim:
1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
4. Body: Forged brass.
5. Ends: Threaded.
6. Seats: PTFE
7. Stem: Stainless Steel.
8. Ball: Chrome-plated brass or Stainless steel, vented
9. Manufacturers:
   a. Apollo
   b. Nibco
   c. Watts

B. Three Piece, Full Port with Stainless Steel Trim:
1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
4. Body: Forged brass.
5. Ends: Threaded.
6. Seats: PTFE
7. Stem: Stainless steel.
8. Ball: Stainless steel, vented.
9. Manufacturers:
   a. Apollo
   b. Nibco
   c. Watts

2.6 BRONZE BALL VALVES

A. Two Piece, Full Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
4. Body: Bronze.
5. Ends: Threaded.
6. Seats: PTFE.
7. Stem: Bronze, brass or stainless steel
8. Ball: Chrome plated brass or stainless steel, vented
9. Manufacturers:
   a. Apollo
   b. Nibco
   c. Watts
   d. Bray International

B. Three Piece, Full Port with Stainless Steel Trim:
1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
4. Body: Bronze.
5. Ends: Threaded.

6. Seats: PTFE.
7. Stem: Stainless steel.
8. Ball: Stainless steel, vented.
9. Manufacturers:
   a. Apollo
   b. Nibco
   c. Watts
   d. Bray International

2.7 CARBON STEEL BALL VALVES

A. Class 300, Full Port, Stainless Steel Trim:
   1. Comply with MSS SP-72.
   2. CWP Rating: 720 psig.
   3. Body: Carbon steel, ASTM A216/A216M, Type WCB.
   4. Ends: Flanged.
   5. Seats: PTFE.
   6. Stem: Stainless steel.
   7. Ball: Stainless steel, vented.
   8. Manufacturers:
      a. _____
      b.
      c.
      d. Substitutions: See Division 01 - General Requirements.

2.8 IRON BALL VALVES

A. Split Body, Full Port:
   1. Comply with MSS SP-72.
   2. CWP Rating: 200 psig.
   3. Body: ASTM A126, gray iron.
   4. Ends: Flanged.
   5. Seats: PTFE.
   6. Stem: Stainless steel.
   7. Ball: Stainless steel.
   8. Manufacturers:
      a. _____
      b.
      c.
      d. Substitutions: See Division 01 - General Requirements.

2.9 IRON, GROOVED-END BALL VALVES

A. Class 200:
   1. CWP Rating: 600 psig.
   2. Body: Ductile iron; ASTM A536, Grade 65-45-12.
   3. Ends: Grooved.
   4. Seats: Teflon.
   5. Stem: Nickel plated carbon steel.
   6. Ball: NIckel plated carbon steel, Type 304 stainless steel.
   7. Manufacturers:
      a. _____
      b. Substitutions: See Division 01 - General Requirements.

2.10 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug type: Bi-directional dead end service without downstream flange.
1. Comply with MSS SP-67, Type I.
2. CWP Rating: 150 psig or 200 psig.
3. Body Material: ASTM A126 cast iron, ASTM A536 ductile iron.
4. Stem: One or two-piece stainless steel.
5. Seat: NBR.
6. Disc: Coated ductile iron.
7. Manufacturers:
a. Nibco, Inc.
b. Crane Co.
c. Grinnell
d. Hammond Valve
e. Milwaukee Valve Co.
f. Bray International

2.11 IRON, GROOVED-END BUTTERFLY VALVES

A. CWP Rating: 175 psig, 300 psig: 8 NPS or smaller, 200 psig: 10 NPS or larger.
1. Comply with MSS SP-67, Type I.
2. Body: Coated ductile iron.
3. Stem: Stainless steel.
4. Disc: Coated ductile iron.
5. Disc Seal: EPDM.
6. Manufacturers:
a. Nibco, Inc.
b. Crane Co.
c. Grinnell
d. Hammond Valve
e. Milwaukee Valve Co.
f. Bray International

2.12 HIGH-PERFORMANCE SINGLE FLANGE BUTTERFLY VALVES

A. Lug type: Bi-directional dead end service without downstream flange.
1. Comply with MSS SP-68.
2. Class 150: CWP Rating: 285 psig, Class 300: CWP Rating: 720 psig.
3. Body: Provide carbon steel, cast iron, ductile Iron, stainless steel.
4. Seat: Metal or reinforced PTFE.
5. Offset stem: Stainless steel.
6. Disc: 316 Stainless Steel
7. Manufacturers:
a. Nibco, Inc.
b. Crane Co.
c. Grinnell
d. Hammond Valve
e. Milwaukee Valve Co.
f. Bray International

2.13 BRONZE LIFT CHECK VALVES

A. Class 125:
1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat, Type 2, Nonmetallic Disc to Metal Seat.
2. CWP Rating: 200 psig.
3. Design: Vertical flow.
4. Body: Bronze.
5. Ends: Threaded.
6. Disc (Type 1): Bronze.
7. Disc (Type 2): NBR or PTFE.
8. Manufacturers:
a. Crane Co.
b. Nibco, Inc.
c. Milwaukee Valve Co.
d. Mueller Steam Specialty

2.14 BRONZE SWING CHECK VALVES

A. Class 125: CWP Rating: 200 psig, Class 150: CWP Rating: 300 psig.
1. Comply with MSS SP-80, Type 3.
2. Body Design: Horizontal flow.
3. Body Material: Bronze, ASTM B62.
4. Ends: Threaded.
5. Disc: Bronze.
6. Manufacturers:
a. Crane Co.
b. Nibco, Inc.
c. Milwaukee Valve Co.

2.15 IRON SWING CHECK VALVES

A. Class 125: CWP Rating: 200 psig with Metal Seats, Class 125: CWP Rating: 150 psig with Metal Seats, Class 250: CWP Rating: 500 psig with Metal Seats, Class 250: CWP Rating: 300 psig with Metal Seats, Class 125: CWP Rating: 200 psig with Nonmetallic-to-Metal Seats.
1. Comply with MSS SP-71, Type I.
2. Design: Clear or full waterway with flanged ends.
3. Body: Gray iron with bolted bonnet in accordance with ASTM A126.
4. Trim: Bronze.
5. Disc Holder: Bronze.
6. Disc: PTFE or TFE.
7. Gasket: Asbestos free.

B. Manufacturers:
a. Crane Co.
b. Nibco, Inc.
c. Milwaukee Valve Co.

2.16 IRON, CENTER-GUIDED SILENT CHECK VALVES

A. Class 125, Globe:
1. Comply with MSS SP-125.
2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
3. 14 NPS to 24 NPS, CWP Rating: 150 psig.
4. Body Material: ASTM A126, gray iron.
5. Style: Spring loaded.
6. Ends: Flanged.
7. Metal Seat: Bronze.
8. Resilient Seat: EPDM, NBR
9. Manufacturers:
   a. Nibco, Inc
   b. Mueller Steam Specialty
   c. Watts

B. Class 150, Globe:
1. Comply with MSS SP-125.
2. 2-1/2 NPS to 12 NPS, CWP Rating: 300 psig.
3. 14 NPS to 24 NPS, CWP Rating: 250 psig.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Spring loaded.
6. Ends: Flanged.
7. Metal Seat: Bronze.
8. Resilient Seat: EPDM, NBR
9. Manufacturers:
   a. Nibco, Inc.
   b. Mueller Steam Specialty
   c. Watts

2.17 BRONZE GATE VALVES

A. Non-Rising Stem (NRS), Rising Stem (RS):
1. Comply with MSS SP-80, Type I.
2. Class125: CWP Rating: 200 psig.
3. Class 150: CWP Rating: 300 psig.
4. Body Material: Bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.
7. Disc: Solid wedge; bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron, bronze, or aluminum.
10. Manufacturers:
    a. Crane Co.
    b. Milwaukee Valve Co.
    c. Watts
    d. Nibco, Inc.

2.18 IRON GATE VALVES

A. NRS, OS & Y
1. Comply with MSS SP-70, Type I.
2. Class 125: 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
3. Class 125: 14 NPS to 24 NPS, CWP Rating: 150 psig.
4. Class 250: 2-1/2 NPS to 12 NPS, CWP Rating: 500 psig.
5. Class 250: 14 NPS to 24 NPS, CWP Rating: 300 psig.
6. Body Material: Gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Disc: Solid wedge.
10. Packing and Gasket: Asbestos free.
11. Manufacturers:
    a. Crane Co.
    b. Milwaukee Valve Co.
    c. Watts
    d. Nibco, Inc.

2.19 ECCENTRIC PLUG VALVES

A. Resilient Seating with Flanged Ends.
1. Comply with MSS SP-108.
2. CWP Rating: 175 psig minimum.
3. Body and Plug: Gray or ductile iron.
4. Bearings: Oil-impregnated bronze or Stainless Steel.
5. Stem-Seal Packing: Asbestos free.
6. Plug, Resilient-Seating Material: Approved for potable water service.
7. Manufacturers:
    a. Mueller
    b. Stockham
    c. DeZurik

2.20 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball, butterfly, plug valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.
5. Manufacturers:
    a. Babbitt Steam Specialty Co.
    b. Roto Hammer Industries
    c. Trumbull Industries

PART 3 EXECUTION

3.1 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve is determined to be defective, replace with new valve.

3.2 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.

3.3 VALVE APPLICATION

A. Valves on condenser water, chilled water, hot water and glycol services shall be as shown in the following tables. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, or gate valves.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service except Steam: Globe or butterfly valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Spring wafer check valve with bronze disc.
      b. NPS 2-1/2 and Larger: Iron, center-guided, metal -seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves with end connections as indicated in the tables. For applications not listed in the tables select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
   2. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
   4. For Steel Piping, NPS 5 and Larger: Flanged ends.

GLYCOL, HOT, AND CHILLED WATER SERVICE Maximum 150°F and 150 psig (1/2 inch - 12 inches), 125 psig (14 inches - 24 inches)					
Specialty	Application	Type	Size (inches)	Body/Seat Body/Trim	Minimum Rating[1,2]
Ball Valve	Isolation (with locking handle) and Modulation	Full Port 3-pc.	1/2 - 2	Bronze/Teflon	400 psig WOG
		Full Port 2 pc.	1/2 - 2	Bronze/Teflon	400 psig WOG
Gate Valve	Not Used				
Globe Valve	ATC Modulation	Control Valve	1/2 - 2	Bronze/Metal	400 psig WOG
			2-1/2 - 6	Bronze/Metal	400 psig WOG
Butterfly Valve	Isolation and Modulation	General Service	2-1/2 - 12	Ductile Iron/EPDM	175 psig CWP 150 psig bi-directional shutoff 150 psig dead end service
		General Service	14 - 24	Ductile Iron/EPDM	150 psig CWP 150 psig bi-directional shutoff 150 psig dead end service
Plug Valve	Manual Balancing	Non-lubricated	3 - 12	Steel/Iron	Class 125
Check Valve	Pumps	Silent	1/2 - 2	Bronze/Bronze	200 psig WOG
		Silent Globe	2-1/2 - 24	Iron/Bronze	Class 125
	Piping	Y-Pattern Swing	1/2 - 2	Bronze/Bronze	200 psig WOG
			2-1/2 - 24	Iron/Bronze	Class 125
Strainer	Control Valves and Flow Meters	Y-Type	1/2 -2	Bronze/Stainless (1/16 inch dia.)	200 psig WOG
			2-1/2 - 4	Iron/Stainless (1/16 inch dia.)	Class 125
			5 - 24	Iron/Stainless (1/8 inch dia.)	Class 125
	Pump Suction	In-Line Y-Type	1/2 - 2	Bronze/Stainless (1/16 inch dia.)	200 psig WOG
			2-1/2 - 4	Iron/Stainless (3/16 inch dia.)[3]	Class 125
			5 - 24	Iron/Stainless (1/4 inch dia.)[3]	Class 125
		Angle Suction Diffuser End Suction Pumps	2 - 12	Iron/Stainless (3/16 inch dia.)[3] Start Up Strainer = 16 Mesh Bronze	Class 125

1. These are minimum ratings for ASTM A126, Class B and ASTM B-61 and 62. For higher pressures and temperatures, adjust these values to include static head plus 1.1 times pressure relief valve setting plus pump shutoff head pressure. For actual maximum allowable valve and strainer ratings, refer to "Pressure-Temperature Ratings - Non Shock" tables and "Adjusted Pressure Ratings" for copper tube, soldered end valves [and strainers].

2. SWP=Steam Working Pressure CWP=Cold Water Working Pressure
   WSP=Working Steam Pressure WOG=Water, Oil or Gas
   Class=ANSI Standard
3. Use 1/8 inch dia for plate heat exchanger application.
4. Coordinate connection type with piping system.

3.4 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

D. Install check valves where necessary to maintain direction of flow as follows:
   1. Lift Check: Install with stem plumb and vertical.
   2. Swing Check: Install horizontal maintaining hinge pin level.
   3. Orient plate-type, center-guided into horizontal or vertical position, between flanges.

E. Provide chainwheels on operators for valves 4 NPS and larger where located 96 NPS or more above finished floor, terminating 60 NPS above finished floor.

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe hangers and supports.

B. Duct hangers and supports

C. Hanger rods.

D. Inserts.

E. Flashing.

F. Formed steel channel.

G. Equipment bases and supports.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:
1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
2. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.

2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

1.4 PERFORMANCE REQUIREMENTS

A. Contractor shall design supports for multiple pipes and/or ducts, including pipe and duct stands, capable of supporting combined weight of supported systems, system contents, and fluid.

B. Contractor shall design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

B. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

C. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Welding certificates.

E. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." and AWS D1.3, "Structural Welding Code--Sheet Steel."

B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum 3 years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following::
1. B-Line Systems, Inc.
2. National Pipe Hanger Corporation
3. Empire Industries, Inc.
4. Globe Pipe Hanger Products Inc.
5. Michigan Hanger Co.
6. PHD Manufacturing, Inc.

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 DUCT HANGERS AND SUPPORTS

A. Shall be in accordance with SMACNA's 2005 "HVAC Duct Construction Standards - Metal and Flexible" except non-engineered wire hangers are not permitted. Engineered cable support systems may be used if they meet SMACNA, Ductmate or approved equal.

B. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

C. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

D. Strap and Rod Sizes: Comply with SMACNA's 2005 "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct.

E. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

F. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

G. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

H. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

I. 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

2.3 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.4 THERMAL SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield. Insert shall be capable of supporting weight of pipe, insulations and fluid without crushing.

B. Manufacturers:
1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Empire Industries, Inc.
3. Hilti, Inc.
4. ITW Ramset/Red Head.
5. MKT Fastening, LLC.
6. Powers Fasteners.

2.6 MISCELLANEOUS MATERIALS

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

B. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

C. Equipment Supports: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

D. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

2.7 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division
4. Unistrut Corp.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.8 ROOF CURBS FOR DUCT AND PIPING PENETRATIONS THROUGH ROOF

A. Manufacturers:
1. Trimco
2. Cambridgeport
3. Pate

B. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, variable step to match root insulation, 1-1/2 inch thick insulation, factory installed wood nailer. Seal duct penetration through roof curb weather tight.

C. Curbs shall be 24” high unless noted otherwise.

D. For other roof curbs refer to Specification Section 23 0548.

2.9 ROOF SUPPORTS FOR HVAC EQUIPMENT, DUCTWORK AND PIPING

A. Refer to Specification Section 23 0548.

PART 3 EXECUTION

3.1 PIPE HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in other Division 23 Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system specific sections, install the following types:
1. MSS Type 1 - Adjustable, Steel Clevis Hangers: For suspension of non-insulated or insulated stationary pipes, 2 inch to 30 inch size.
2. MSS Type 2 - Yoke-Type Pipe Clamps: For suspension of 120 to 450 deg F pipes, 4 inch to 16 inch size, requiring up to 4 inches of insulation.
3. MSS Type 3 - Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps: For suspension of pipes, 3/4 inch to 24 inch size, requiring clamp flexibility and up to 4 inches of insulation.
4. MSS Type 4 - Steel Pipe Clamps: For suspension of cold and hot pipes, 1/2 inch to 24 inch size, if little or no insulation is required.
5. MSS Type 5 - Pipe Hangers: For suspension of pipes, 1/2 inch to 4 inch size, to allow off-center closure for hanger installation before pipe erection.
6. MSS Type 12 - Extension Hinged or 2-Bolt Split Pipe Clamps: For suspension of non-insulated stationary pipes, 3/8 inch to 3 inch size.
7. MSS Type 24 - U-Bolts: For support of heavy pipes, 1/2 inch to 30 inch.
8. MSS Type 26 - Clips: For support of insulated pipes not subject to expansion or contraction.
9. MSS Type 36 - Pipe Saddle Supports: For support of pipes, 4 inch to 36 inch size, with steel pipe base stanchion support and cast-iron floor flange.
10. MSS Type 37 - Pipe Stanchion Saddles: For support of pipes, 4 inch to 36 inch size, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
11. MSS Type 38 - Adjustable, Pipe Saddle Supports: For stanchion-type support for pipes, 2-1/2 inch to 36 inch size, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

12. MSS Type 41 - Single Pipe Rolls: For suspension of pipes, 1 inch to 30 inch size, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
13. MSS Type 43 - Adjustable Roller Hangers: For suspension of pipes, 2-1/2 inch to 20 inch size, from single rod if horizontal movement caused by expansion and contraction might occur.
14. MSS Type 44 - Complete Pipe Rolls: For support of pipes, 2 inch to 42 inch size, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
15. MSS Type 45 - Pipe Roll and Plate Units: For support of pipes, 2 inch to 24 inch, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
16. MSS Type 46 - Adjustable Pipe Roll and Base Units: For support of pipes, 2 inch to 30 inch size, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. MSS Type 8 - Extension Pipe or Riser Clamps: For support of pipe risers, ¾ inch to 20 inch size.
2. MSS Type 42 - Carbon- or Alloy-Steel Riser Clamps: For support of pipe risers, 3/4 inch to 20 inch size, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. MSS Type 13 - Steel Turnbuckles: For adjustment up to 6 inches for heavy loads.
2. MSS Type 14 - Steel Clevises: For 120 to 450 deg F piping installations.
3. MSS Type 15 - Swivel Turnbuckles: For use with MSS Type 11, split pipe rings.
4. MSS Type 16 - Malleable-Iron Sockets: For attaching hanger rods to various types of building attachments.
5. MSS Type 17 - Steel Weldless Eye Nuts: For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. MSS Type 18 - Steel or Malleable Concrete Inserts: For upper attachment to suspend pipe hangers from concrete ceiling.
2. MSS Type 19 - Top-Beam C-Clamps: For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. MSS Type 20 - Side-Beam or Channel Clamps: For attaching to bottom flange of beams, channels, or angles.
4. MSS Type 21 - Center-Beam Clamps: For attaching to center of bottom flange of beams.
5. MSS Type 22 - Welded Beam Attachments: For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. MSS Type 23 - C-Clamps: For structural shapes.
7. MSS Type 25 - Top-Beam Clamps: For top of beams if hanger rod is required tangent to flange edge.
8. MSS Type 27 - Side-Beam Clamps: For bottom of steel I-beams.
9. MSS Type 28 - Steel-Beam Clamps with Eye Nuts: For attaching to bottom of steel I-beams for heavy loads.

10. MSS Type 29 - Linked-Steel Clamps with Eye Nuts: For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. MSS Type 30 - Malleable Beam Clamps with Extension Pieces: For attaching to structural steel.
12. 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:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. MSS Type 34 - Side-Beam Brackets: For sides of steel or wooden beams.
14. MSS Type 57 - Plate Lugs: For attaching to steel beams if flexibility at beam is required.
15. MSS Type 58 - Horizontal Travelers: For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. MSS Type 39 - Steel Pipe-Covering Protection Saddles: To fill interior voids with insulation that matches adjoining insulation.
2. MSS Type 40 - Protection Shields: Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. MSS Type 47 - Restraint-Control Devices: Where indicated to control piping movement.
2. MSS Type 48 - Spring Cushions: For light loads if vertical movement does not exceed 1-1/4 inches.
3. MSS Type 49 - Spring-Cushion Roll Hangers: For equipping Type 41 roll hanger with springs.
4. MSS Type 50 - Spring Sway Braces: To retard sway, shock, vibration, or thermal expansion in piping systems.
5. MSS Type 51 - Variable-Spring Hangers: Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. MSS Type 52 - Variable-Spring Base Supports: Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. MSS Type 53 - Variable-Spring Trapeze Hangers: Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

3.2 PIPE HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System for Multiple Hangers: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
3. Floor Support: concrete pier or steel support.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

H. 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.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. 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.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. 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.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   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.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

N. Design hangers for pipe movement without disengagement of supported pipe.

O. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 23 07 00 Provide supplemental angles, channels and formed steel supports to support piping, ductwork, equipment, etc. from building’s structure. Piping, ductwork, equipment, etc. shall not be supported from the roof deck.

3.3 DUCT HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's 2005 "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

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 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.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's 2005 "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "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.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

3.4 EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports to suspend equipment from structure overhead or to support equipment above floor. Fabricate supports from welded-structural steel shapes. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 21 05 48.

3.5 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 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 contours of welded surfaces match adjacent contours.

3.6 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.

3.7 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 2)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4
10	18	22	3/4	7/8
12	19	23	3/4	7/8
14	22	25	7/8	1
16	23	27	7/8	1
18	25	28	1	1
20	27	30	1	1-1/4
24	28	32	1-1/4	1-1/4

B. Plastic and Ductile Iron Pipe Hanger Spacing:

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
ABS (All sizes)	4	3/8
FRP (All Sizes)	4	3/8
Ductile Iron (Note 2)		
PVC (All Sizes)	4	3/8

C. Note 1: Refer to manufacturer's recommendations for grooved end piping systems.

D. Note 2: 20 feet maximum spacing, minimum of one hanger for each pipe section close to joint behind bell. Provide hanger at each change of direction and each branch connection. For pipe sizes 6 inches and smaller, subjected to loadings other than weight of pipe and contents, limit span to maximum spacing for water service steel pipe.

END OF SECTION

SECTION 230548

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Intent
1. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
3. This specification is considered to be minimum requirements for seismic consideration as required for life safety.
4. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

B. The work of this section includes but is not limited to the following:
1. Vibration isolation elements.
2. Equipment isolation bases.
3. Piping flexible connections.
4. Seismic restraints for any mechanical components with Component Importance Factor of Ip = 1.5 as defined by ASCE 7; Chapter 13 – latest edition.
5. Wind restraints as defined by ASCE 7; Chapter 26 – latest edition.

1.2 QUALIFICATIONS

A. Qualifications: Only firms having five years experience designing and manufacturing isolation and restraint devices shall be capable of work in this specification.

1.3 SUBMITTALS

A. Submit under provisions of Division 1 and Section 23 04 00.

B. The submittal material shall include copies of descriptive data for all products and materials including but not limited to the following:
1. Descriptive Data: Catalog cuts or data sheets.
2. Shop Drawings:
a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

C. The submittal material shall include copies of descriptive data for all products and materials including but not limited to the following:
1. Descriptive Data: Catalog cuts or data sheets.
2. Shop Drawings:
a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
b. Provide Drawings showing methods of suspension and support guides for conduit, piping, ductwork and ceiling hung equipment.

c. Drawings showing methods for isolation of conduits, pipes and ductwork penetrating walls and floor slabs.
d. Drawings shall show housekeeping pad reinforcement and monolithic pad attachment to the structure.

3. Wind Certification and Analysis:
a. Wind restraint calculations shall be provided for all connections of equipment to the structure. Calculations shall be stamped by a registered professional engineer with at least five years of design experience, licensed in the state of the job location.
b. Analysis shall indicate calculated dead loads, wind loads and capacity of materials utilized for connections to equipment and structure. Analysis shall detail anchoring methods, bolt diameter, embedment and/or welded length.

4. Roof curb and roof rail attachments: Refer to details on structural drawings. Method of attachment shall conform to details on structural drawings.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall have the following responsibilities:
1. Provide and install isolation systems and wind restraints as scheduled or specified.
2. Guarantee specified isolation system deflection.
3. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.5 RELATED WORK

A. Supplementary Support Steel
1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

B. Attachments
1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 and Section 23 04 00.

B. Record actual locations and installation of vibration isolators and restraints including attachment points.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Mason Industries Inc. and Novia models listed below.

B. Other approved manufacturers providing equivalent products include:
1. Pate.

2. Vibro-Acoustics Ltd

2.2 PRODUCT DESCRIPTIONS

A. Vibration Isolators and Seismic Restraint Specifications
1. Specification 1 - Neoprene Pad
a. Two layers of 3/4" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required.
b. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
2. Specification 2 - Bridge - Bearing Neoprene Mountings
a. Bridge bearing neoprene mountings shall have a minimum static deflection of 0.2" and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge bearing specifications. Mountings shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
b. Mountings shall be Type BR as manufactured by Mason Industries, Inc.
3. Specification 3 – Bushing Assemblies
a. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality.
b. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.
4. Specification 4 - Neoprene Bushing
a. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact.
b. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
5. Specification 5 – Spring Isolators
a. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.
b. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
6. Specification 6 – Restrained Spring Mountings

a. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Preapproval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings.
b. Mountings shall be SLR as manufactured by Mason Industries, Inc.

7. Specification 7 – Spring Mountings
   a. Spring mountings as in specification 5 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4" travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Preapproval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
   b. Mountings shall be SSLFH as manufactured by Mason Industries, Inc.
8. Specification 8 – Air Springs
   a. Air springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8" Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician.
   b. Air Springs shall be Type MT and leveling valves Type LV as manufactured by Mason Industries, Inc.
9. Specification 9 – Restrained Air Springs
   a. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces.
   b. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc.
10. Specification 10 – Hangers
    a. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and

hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30o arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30o capability.

b. Hangers shall be type 30N as manufactured by Mason Industries, Inc.

11. Specification 11 – Hangers
    a. Hangers shall be as described in 10, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic up-stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30o capability.
    b. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
12. Specification 12 – Not Used
13. Specification 13 – Not Used
14. Specification 14 – Rod Clamp Assemblies
    a. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.
    b. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
15. Specification 15 – Clevis Hanger Cross Brace
    a. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.
    b. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
16. Specification 16 - Not Used
17. Specification 17 – Inertia Foundations
    a. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6". The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1 1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.
18. Specification 18 – Stud Wedges
    a. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads.

b. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.

19. Specification 19 – Female Wedge Anchors
    a. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying to its allowable loads.
    b. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.
20. Specification 20 – Flexible Stainless Steel Hoses
    a. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

Flanged		Male Nipples	
3 x 14	10 x 26	1/2 x 9	1 1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2 1/2 x 18
6 x 20	16 x 32	1 1/4 x 12	
8 x 22			

    b. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.
    c. Hoses shall be type BSS as manufactured by Mason Industries, Inc.
21. Specification 21 - All-Directional Acoustical Pipe Anchor
    a. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
    b. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.
22. Specification 22 – Pipe Guides
    a. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of + 1 5/8" motion, or to meet location requirements.
    b. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.
23. Specification 23 - Split Wall Seals
    a. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals

shall project a minimum of l" past either face of the wall. Where temperatures exceed 240o F. 10# density fiberglass may be used in lieu of the sponge.

b. Seals shall be Type SWS as manufactured by Mason Industries, Inc.

24. Specification 24 – Pipe Expansion Joints at Building Expansion Joints
    a. Flexible Type 304 stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples.
    b. Hoses shall be type 60 degree VEE as manufactured by Mason Industries, Inc.
25. Specification 25 – Roof Curbs with Vibration Isolation and Acoustical Panels
    a. Curbs shall provide continuous support for the equipment and shall be designed to resist wind forces. Construction shall be minimum 14 gauge, G60 galvanized steel. All side & end seams between sheets shall be continuously welded, corner joints shall be bolted. All spring locations shall have removable waterproof galvanized steel covers to allow for spring adjustment and/or replacement. All duct and piping penetrations in the panels shall be sealed with a non hardening caulk.
    b. All curbs shall be flat with custom stanchions to match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise. Curb stanchions shall account for “compound/double pitched” roof valleys or roof peaks. Refer to architectural roof plans for locations.
    c. Curbs shall be externally factory insulated with 1.7” thick R-10.3 foam insulation, FM Class 1 and UL Class A Ratings, with bonded fiber reinforced facer.
    d. Curbs shall be capped with 7 mil shrink wrap for weather protection.
    e. Curbs shall supply 2” deflection capability.
    f. Curbs shall be factory fabricated to a height large enough to allow the bottom of the spring access port to be located a minimum of 8” above the height of the finished flashed roof including the roofing insulation.
    g. Provide support angles and cross braces for acoustical panels which shall be installed throughout the entire roof curb. Provide acoustical panels constructed of 4” thick, 3 lb mineral wool insulation between 22 gauge (bottom side) and 18 gauge perforated (top side facing unit) aluminized outer skins. Support channels shall be 18 gauge galvanized steel. Acoustical panels shall be as manufactured by George Koch Acoustical Panels.
    a. Curb shall be Mason Industries Type RSC or Novia VibCurb.
26. Specification 26 – Roof Curbs with Vibration Isolation:
    a. Curbs shall provide continuous support for the equipment and shall be designed to resist wind forces. Construction shall be minimum 14 gauge, G60 galvanized steel. All side & end seams between sheets shall be continuously welded, corner joints shall be bolted. All spring locations shall have removable waterproof galvanized steel covers to allow for spring adjustment and/or replacement. All duct and piping penetrations in the panels shall be sealed with a non hardening caulk.
    b. All curbs shall be custom, pitched curbs; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise. Curbs shall be “compound/double pitched” where curbs cross roof valleys or roof peaks. Refer to architectural roof plans for locations.
    c. Curbs shall be externally factory insulated with 1.7” thick R-10.3 foam insulation, FM Class 1 and UL Class A Ratings, with bonded fiber reinforced facer.

d. Curbs shall be capped with 7 mil shrink wrap for weather protection.
e. Curbs shall supply 2” deflection capability.
f. Curbs shall be factory fabricated to a height large enough to allow the bottom of the spring access port to be located a minimum of 8” above the height of the finished flashed roof including the roofing insulation.
g. Curb shall be Mason Industries Type RSC or Novia VibCurb.

27. Specification 27 – Roof Curbs
    a. Curbs shall provide continuous support for the equipment and shall be designed to resist wind and seismic forces. Construction shall be minimum 12 gauge galvanized steel. Provide support angles and cross braces for acoustical panels which shall be installed throughout the entire roof curb. All duct and piping penetrations in the panels shall be sealed with a non hardening caulk. All curbs shall be custom, pitched curbs; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise. Curbs shall be 24” high unless noted otherwise. Curb shall be Pate PC-4.
28. Specification 28 – Roof Rails Supporting Equipment, Ductwork and Piping
    a. Supports shall be Novia Model FRR.
    b. Equipment Supports: Spring isolation type; minimum 1” deflection.
    c. Ductwork and Piping: Spring isolation type within 50’ of equipment connections and non-isolated at distance of 50’ away from equipment connections
    d. Rails shall bear directly on the roof structure and are flashed and waterproofed into the roof's membrane waterproofing system. Field fabricated rails with external isolators shall not be used. Metal flashing that must be rigidly attached to the floating and non-floating portions of the rail which would short circuit the isolation effectiveness are not acceptable. Waterproofing shall be achieved by use of a continuous flexible water seal attached to the bottom counter flashing. The seal shall be protected from exposure to the elements by the top flashing. All rails shall be custom, pitched rails; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise.
    e. Rails shall include the following features:
        1) Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4-inch thick.
        2) Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces.
        3) Top rail to be formed of 14-gauge minimum G60 galvanized steel with a minimum of two nested layers (or equivalent thickness).
        4) Rails shall be self-supporting without the use of cross bracing.

PART 3 EXECUTION

3.1 GENERAL

A. Vibration isolators and wind restraint systems shall control excessive noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolators and wind restraint units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.

B. All vibration isolators and wind restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

C. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

E. The contractor shall not install any equipment, piping, duct or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

F. Coordinate work with other trades to avoid rigid contact with the building.

G. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor’s expense.

H. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor’s expense.

I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
   1. Flanges of structural beams.
   2. Upper truss cords in bar joist construction.
   3. Cast in place inserts or wedge type drill-in concrete anchors.

J. Restraints and isolators installed outside or other locations exposed to weather shall be constructed of weather proof materials including galvanized steel structural frames, stainless steel threaded rods, stainless steel hardware, etc

K. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

L. Specification 12 cable assemblies are installed taut on non-isolated systems.

M. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification 23 wall seals.

N. Building Expansion Joints:
   1. Refer to architectural drawings for all locations of building expansion joints.
   2. All piping crossing building expansion joints shall be provided with Specification 24.

3.2 VIBRATION ISOLATION RESTRAINT INSTALLATION

A. Vibration Isolation of Horizontal Piping: The first 50’ of piping connected to mechanical equipment including air handling units and pumps shall be isolated by hangers as described in specification 10 or 11. All piping in the boiler rooms / mechanical rooms shall

be isolated by hangers as described in specification 10 or 11. All piping 4: diameter and larger shall be isolated by hangers as described in specification 10 or 11. Brace hanger rods with SRC clamps specification 14. Floor supported piping shall rest on isolators as described in specification 6. Heat exchanger's and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical.

B. Vibration Isolation of Piping Risers: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to + 25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

C. Seismic Restraint of Piping
1. Provide seismic restraints for any mechanical components with Component Importance Factor of Ip = 1.5 as defined by ASCE Chapter .7
2. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

D. Vibration Isolation of Ductwork
1. All discharge runs for a distance of 50' from the connected equipment shall be isolated from the building structure by means of specification 10 hangers or specification 5 floor isolators. Spring deflection shall be a minimum of 0.75".
2. All duct runs having air velocity of 1000 fpm or more shall be isolated from the building structure by specification 11 hangers or specification 5 floor supports. Spring deflection shall be a minimum of 0.75".

E. Concrete Inertia Bases
1. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".
2. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
3. The isolators shall be installed without raising the machine and frame assembly.
4. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
5. Install equipment with flexibility in wiring connection.
6. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".

7. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators, or seismic restraints.

F. Seismic Anchoring of Mechanical Equipment: The following equipment and accessories shall be seismically anchored:
1. Fuel oil tank, fuel oil pumps, day tanks, piping and accessories.
2. Gas fired radiant heaters.
3. Boilers.

G. Vibration Isolation / Anchoring of Mechanical Equipment
1. All mechanical equipment with motors, rotating elements, etc. shall be vibration isolated including fans, unit heaters, pumps, etc.
2. All floor mounted equipment shall be installed on housekeeping pads. Equipment shall be anchored to pads to meet acceleration criteria. Concrete pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
3. Base mounted/floor mounted pumps shall be installed on concrete inertia bases.
4. Pumps: All piping connections to pumps shall be made with specification 20.
5. All mechanical equipment suspended from the building's structure shall be vibration isolated with combinations of Specification 5 thru 17.
6. All hung equipment shall be installed with specification 10 cables if isolated. Specification 10 or 11 restraints may be used on un-isolated equipment and devices. Hung equipment includes in-line fans, VAV boxes, unit heaters, pipe mounted equipment, etc.
7. Specification 25 - Roof Curbs with Vibration Isolation and Acoustical Panels: Equipment listed below shall be anchored with this specification. Units shall be mounted at minimum 24" above roof to the bottom of the equipment – measurement is to be taken at the point where the curb is at the roof's highest point (pitched roofs). Roof curbs shall be anchored to the roof structure.
   a. Roof Mounted Air Handling Units including pipe enclosures.
   b. Centrifugal Utility Fans.
8. Specification 26 - Roof Curbs with Vibration Isolation: Equipment listed below shall be anchored with this specification. Units shall be mounted at minimum 18" above roof to the bottom of the equipment – measurement is to be taken at the point where the curb is at the roof's highest point (pitched roofs). Roof curbs shall be anchored to the roof structure and shall be in compliance with wind design criteria.
   a. Roof Mounted Upblast Fans.
   b. Roof Mounted Downblast Fans.
   c. Roof Mounted Utility Set Fans.
9. Specification 28 - Roof Rails: Equipment listed below shall be anchored with this specification. Units shall be mounted at minimum 18" above roof to the bottom of the equipment – measurement is to be taken at the point where the curb is at the roof's highest point (pitched roofs). Rails shall be anchored to the roof structure and shall be self-supporting without cross bracing allowing full access under the units. Anchoring shall be in compliance with wind design criteria.
   a. Condensing Units serving VRF systems and split AC units
   b. All piping installed above the roof.
   c. All ductwork installed above the roof.

3.3 INSPECTION

A. Examine systems under provisions of Division 1.

B. On completion of installation of all vibration isolation devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Duct Markers.

D. Pipe markers.

E. Warning Signs and Labels

F. Warning Tags

G. Radon Labels

H. Ceiling Tacks

1.2 RELATED REQUIREMENTS

A. All identification shall match Owner standards and be coordinated with Owner's Facility Department prior to submittal.

B. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

C. Division 09- Finishes.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. ASME A13.1 - Scheme for the Identification of Piping Systems.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.

1.4 SUBMITTALS

A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

E. Project Record Documents:
1. Valve Schedules: For each piping system. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
2. Equipment Schedules: For each item of equipment to be labeled. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

PART 2 PRODUCTS

2.1 EQUIPMENT NAMEPLATES

A. Manufacturers:
1. Advanced Graphic Engraving, LLC
2. Brimar Industries, Inc; Kolbi Pipe Marker Co.
3. Seton Identification Products

B. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032-inch, Stainless steel, 0.025-inch, Aluminum, 0.032-inchor anodized aluminum, 0.032-inchminimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inchfor viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Plastic Labels for Equipment:
1. Material and Thickness: Conform to ASTM D709. Multilayer, multicolor, plastic labels for mechanical engraving, minimum 1/16 inchthick, 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. Minimum Letter Size: 1/4 inchfor name of units if viewing distance is less than 24 inches, 1/2 inchfor viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

D. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 TAGS

A. Manufacturers:
1. Advanced Graphic Engraving
2. Brady Corporation
3. Brimar Industries, Inc
4. Kolbi Pipe Marker Co
5. Seton Identification Products, a Tricor Company
6. Substitutions: See Division 01-General Requirements.

B. Metal Tags: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware. Brass wire-link, beaded chain or S-hook fasteners. Minimum 1-1/2 inch diameter with smooth edges.

2.3 DUCT MARKERS

A. Manufacturers:
1. Brimar Industries, Inc
2. Kolbi Pipe Marker Co
3. Seton Identification Products

B. General Requirements for Manufactured Duct Labels: Preprinted self-adhesive, premium grade vinyl, color-coded, with lettering indicating service, and showing flow direction.

C. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch printed with UV and chemical resistant inks.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

F. Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, 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. Lettering Size: Prepared with letter sizes according to ASME A13.1, at least 1-1/2 incheshigh.

2.4 PIPE MARKERS

A. Manufacturers:
1. Brady Corporation
2. Brimar Industries, Inc
3. Kolbi Pipe Marker Co
4. MIFAB, Inc
5. Seton Identification Products

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, 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: Prepared with letter sizes according to ASME A13.1, at least 1-1/2 incheshigh.

2.5 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inchthick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inchfor 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-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.6 WARNING TAGS

A. Warning Tags: 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: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Red, white, black.

2.7 CEILING TACKS

A. Manufacturers:
1. Brimar
2. Craftmark

B. Seton Identification ProductsDescription: Steel with 3/4 inch diameter color coded head.

C. Color code as follows:
1. HVAC Equipment: Yellow.
2. Fire Dampers and Smoke Dampers: Red.
3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment, including all scheduled equipment on the drawings, air terminal units, automatic control devices, control panels, instruments, relays and major control components.

B. Locate equipment labels where accessible and readable from the floor.

C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

3.3 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:
1. Valve-Tag Size and Shape: 1-1/2 inches, round.
2. Valve-Tag Color: Natural
3. Letter Color: Black

3.4 PIPE LABEL INSTALLATION

A. Install plastic pipe markers in accordance with manufacturer's instructions.

B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

C. 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 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. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

E. Pipe Label Color Schedule:
1. Potable, Cooling, Heating and Other Water Piping:
   a. Background Color: Green.
   b. Letter Color: White.
2. Combustible Fluid Piping:
   a. Background Color: Brown.
   b. Letter Color: White.
3. Flammable & Oxidizing Fluid Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.
4. Toxic & Corrosive Piping:
   a. Background Color: Orange.
   b. Letter Color: Black.

F. Identify valves in main and branch piping with tags.

3.5 DUCT LABEL INSTALLATION

A. Install duct labels with permanent adhesive on air ducts in the following color codes:
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.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 CEILING TACK INSTALLATION

A. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.7 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic, steam, and refrigerating systems.

C. Measurement of final operating condition of HVAC systems.

D. Sound measurement of equipment operating conditions.

E. Vibration measurement of equipment operating conditions.

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. AABC (NSTSB) - AABC National Standards for Total System Balance

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.

C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems;.

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing;.

1.4 SUBMITTALS

A. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to Architect.
   2. Submit to the Commissioning Authority.
   3. Submit to Engineer of Record.
   4. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   5. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
   6. Include at least the following in the plan:
      a. Preface: An explanation of the intended use of the control system.

b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
d. Identification and types of measurement instruments to be used and their most recent calibration date.
e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
f. Final test report forms to be used.
g. Detailed step-by-step procedures for TAB work for each system and issue, including:
    1) Terminal flow calibration (for each terminal type).
    2) Diffuser proportioning.
    3) Branch/submain proportioning.
    4) Total flow calculations.
    5) Rechecking.
    6) Diversity issues.
h. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
i. Details of how TOTAL flow will be determined; for example:
    1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
    2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
k. Confirmation of understanding of the outside air ventilation criteria under all conditions.
l. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
m. Method of checking building static and exhaust fan and/or relief damper capacity.
n. Methods for making coil or other system plant capacity measurements, if specified.
o. Time schedule for TAB work to be done in phases (by floor, etc.).
p. Description of TAB work for areas to be built out later, if any.
q. Time schedule for deferred or seasonal TAB work, if specified.
r. False loading of systems to complete TAB work, if specified.
s. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
t. Interstitial cavity differential pressure measurements and calculations, if specified.
u. differential pressure measurements and calculations between the building and its exterior.
v. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
w. Procedures for formal progress reports, including scope and frequency.
x. Procedures for formal deficiency reports, including scope, frequency and distribution.

C. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit under provisions of Division 01 – General Conditions.
   2. Submit to the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
   3. Revise TAB plan to reflect actual procedures and submit as part of final report.
   4. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and Engineer of Record and for inclusion in operating and maintenance manuals.
   5. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
   6. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
   7. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
   8. Units of Measure: Report data in both I-P (inch-pound) units.
   9. Include the following on the title page of each report:
      a. Name of Testing, Adjusting, and Balancing Agency.
      b. Address of Testing, Adjusting, and Balancing Agency.
      c. Telephone number of Testing, Adjusting, and Balancing Agency.
      d. Project name.
      e. Project location.
      f. Project Architect.
      g. Project Engineer.
      h. Project Contractor.
      i. Project altitude.
      j. Report date.

E. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
   3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
   4. SMACNA (TAB)Maintain at least one copy of the standard to be used at project site at all times.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

D. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of three years documented experience.
   3. Certified by one of the following:
      a. AABC, Associated Air Balance Council completion submit AABC National Performance Guaranty.
      b. NEBB, National Environmental Balancing Bureau
      c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage is minimized.
   12. Hydronic systems are flushed, filled, and vented.
   13. Pumps and fans are rotating correctly.
   14. Proper strainer baskets are clean and in place.
   15. Service and balance valves are open.

3.3 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers and control providers whose work will be tested, adjusted, or balanced.

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

H. Check and adjust systems approximately two seasons after final acceptance and submit report.

3.6 AIR SYSTEM PROCEDURE

A. Work with Control vendor to establish minimum setpoints necessary to satisfy contract documents. Iterative testing to determine these minimum setpoints will be expected to be in the submittals.

B. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

C. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

D. Measure air quantities at air inlets and outlets.

E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

F. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

G. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.7 WATER SYSTEM PROCEDURE

A. Work with Control vendor to establish minimum setpoints necessary to satisfy contract documents. Iterative testing to determine these minimum setpoints will be expected in the submittals.

B. Adjust water systems to provide required or design quantities.

C. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

D. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

E. Effect system balance with automatic control valves fully open to heat transfer elements.

F. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

G. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 COMMISSIONING

A. See Division 01 General Requirements for additional requirements.

3.9 SCOPE

A. Test, adjust, and balance the following:
1. Plumbing Pumps.
2. HVAC Pumps.
3. Boilers
4. Air Coils.
5. Terminal Heat Transfer Units.
6. Air Handling Units, rooftop units, makeup air units, energy recovery ventilators, etc.
7. Fans.
8. Air Filters.
9. Air Terminal Units.
10. Air Inlets and Outlets.
11. Chillers
12. Electric heating elements

3.10 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, voltage, amperage; nameplate, actual, no load.
5. RPM.
6. Service factor.
7. Starter size, rating, heater elements.
8. Sheave Make/Size/Bore.
9. VFD Setpoints.
10. ECM Setpomts.

B. V-Belt Drives:
1. Identification/location.
2. Required driven RPM.
3. Driven sheave, diameter and RPM.
4. Belt, size and quantity.
5. Motor sheave diameter and RPM.
6. Center to center distance, maximum, minimum, and actual.

C. Pumps:
1. Identification/number.
2. Manufacturer.
3. Size/model.
4. Impeller.
5. Service.
6. Design flow rate, pressure drop, BHP.
7. Actual flow rate, pressure drop, BHP.
8. Discharge pressure.
9. Suction pressure.

10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.

D. Combustion Equipment:
1. Boiler manufacturer.
2. Model number.
3. Serial number.
4. Firing rate.
5. Overfire draft.
6. Gas meter timing dial size.
7. Gas meter time per revolution.
8. Gas pressure at meter outlet.
9. Gas flow rate.
10. Heat input.
11. Burner manifold gas pressure.
12. Percent carbon monoxide (CO).
13. Percent carbon dioxide (CO2).
14. Percent oxygen (O2).
15. Percent excess air.
16. Flue gas temperature at outlet.
17. Ambient temperature.
18. Net stack temperature.
19. Percent stack loss.
20. Percent combustion efficiency.
21. Heat output.

E. Cooling Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air DB temperature, design and actual.
7. Entering air WB temperature, design and actual.
8. Leaving air DB temperature, design and actual.
9. Leaving air WB temperature, design and actual.
10. Water flow, design and actual.
11. Water pressure drop, design and actual.
12. Entering water temperature, design and actual.
13. Leaving water temperature, design and actual.
14. Saturated suction temperature, design and actual.
15. Air pressure drop, design and actual.

F. Heating Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.

9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

G. Electric Duct Heaters:
1. Manufacturer.
2. Identification/number.
3. Location.
4. Model number.
5. Design kW.
6. Number of stages.
7. Phase, voltage, amperage.
8. Test voltage (each phase).
9. Test amperage (each phase).
10. Air flow, specified and actual.
11. Temperature rise, specified and actual.

H. Air Moving Equipment:
1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Arrangement/Class/Discharge.
6. Air flow, specified and actual.
7. Return air flow, specified and actual.
8. Outside air flow, specified and actual.
9. Total static pressure (total external), specified and actual.
10. Inlet pressure.
11. Discharge pressure.
12. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.

I. Return Air/Outside Air:
1. Identification/location.
2. Design air flow.
3. Actual air flow.
4. Design return air flow.
5. Actual return air flow.
6. Design outside air flow.
7. Actual outside air flow.
8. Return air temperature.
9. Outside air temperature.
10. Required mixed air temperature.
11. Actual mixed air temperature.
12. Design outside/return air ratio.
13. Actual outside/return air ratio.

J. Exhaust Fans:
1. Location.
2. Manufacturer.
3. Model number.

4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
9. Sheave Make/Size/Bore.
10. Number of Belts/Make/Size.
11. Fan RPM.

K. Duct Traverses:
1. System zone/branch.
2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.
9. Air temperature.
10. Air correction factor.

L. Duct Leak Tests:
1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus:
    a. Blower.
    b. Orifice, tube size.
    c. Orifice size.
    d. Calibrated.
7. Test static pressure.
8. Test orifice differential pressure.
9. Leakage.

M. Air Monitoring Stations:
1. Identification/location.
2. System.
3. Size.
4. Area.
5. Design velocity.
6. Design air flow.
7. Test velocity.
8. Test air flow.

N. Flow Measuring Stations:
1. Identification/number.
2. Location.
3. Size.
4. Manufacturer.
5. Model number.
6. Serial number.

7. Design Flow rate.
8. Design pressure drop.
9. Actual/final pressure drop.
10. Actual/final flow rate.
11. Station calibrated setting.

O. Terminal Unit Data:
1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.
5. Model number.
6. Size.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.

P. Air Distribution Tests:
1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

Q. Ductless Split:
a. Location
b. Serial number
c. Entering DB air temperature, design and actual
d. Leaving DB air temperature, design and actual

3.11 POST OCCUPANCY BALANCING

A. Contractor shall perform (2) additional site visits after spaces have been occupied to rebalance systems as direct by the Owner or Engineer. These site visits shall encompass changes as directed by the Owner and shall not encompass changes or modifications made by the contractor which have resulted in the need to rebalance systems. Each site visit shall be a duration of four hours and shall include balancing of air and/or water systems.

END OF SECTION

SECTION 230700

HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. HVAC piping insulation, jackets and accessories.
2. HVAC equipment insulation, jackets and accessories.
3. HVAC ductwork insulation, jackets, and accessories.
4. Electric heat tracing.

B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
3. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 REFERENCES

A. International Energy Conservation Code, latest edition.

B. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
7. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
8. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
9. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
10. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
11. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
12. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
13. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
14. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).

15. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
16. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
17. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
18. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
19. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

C. Sheet Metal and Air Conditioning Contractors' National Association':
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

D. Underwriters Laboratories Inc.:
   1. UL 1978 - Standard for Safety for Grease Ducts.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. As a minimum requirement, all products and installation methods shall comply with 2012 International Energy Conservation Code.

B. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

C. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

D. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

E. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

F. All insulating materials shall be free of asbestos.

G. All insulating products and coverings shall be UL listed.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience as approved by manufacturer.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
1. CertainTeed.
2. Knauf.
3. Johns Manville.
4. Owens-Corning.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
1. Aeroflex. Aerocel.
2. Armacell, LLC. Armaflex.
3. Nomaco. K-flex.

C. Manufacturers for Adhesives and Sealers:
1. Benjamin Foster (H.B. fuller Co.)
2. Rubatex.

3. Minnesota Mining and Mfg Co. (3M)

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

2.3 PIPE INSULATION JACKETS

A. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1785, one piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 10 mil.
3. Connections: Brush on welding adhesive; vapor retardant with pressure sensitive color matching vinyl tape.
4. Fittings and Valves: provide factory precut inserts.
5. For exterior locations, PVC jacket shall be UV resistant.

B. Aluminum Pipe Jacket:
1. ASTM B209.
2. Thickness: 0.020 inch thick sheet.
3. Finish: Smooth.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: Minimum 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: Minimum 3/8 inch wide; 0.02inch thick aluminum.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Insulation saddle. Insert length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum jacket single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

G. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 1.65 pound per cubic foot.

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied reinforced aluminum foil jacket.
1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 3.0 pound per cubic foot.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

C. TYPE E-3: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:
1. Product Description: ASTM D1785, sheet material, off-white color.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
3. Thickness: 20 mil.
4. Connections: Brush on welding adhesive with tacks.

B. Aluminum Equipment Jacket:
1. ASTM B209Thickness: 0.032 inch thick sheet.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.016 thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

C. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Adhesives: Compatible with insulation.

2.8 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Operating Temperature: 250 degrees F.
3. Density: 1.0 pound per cubic foot.

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied reinforced aluminum foil facing meeting ASTM C1136, Type II.
   1. Thermal Conductivity: 0.23 at 75 degrees F.
   2. Density: 6.0 pound per cubic foot.

C. TYPE D-3: "Acoustical Duct Wrap" flexible, mass loaded vinyl laminated to fiberglass.
   1. Manufacturers: Sound Seal "B-20 LAG/QFA-9.
   2. Thickness: 2".
   3. Density: 2.0 lb/sf ft.
   4. R-factor: 9.0

D. TYPE D-4: Not used

2.9 DUCTWORK INSULATION JACKETS

A. Aluminum Duct Jacket:
   1. ASTM B209.
   2. Thickness: 0.020 inch thick sheet.
   3. Finish: Smooth.
   4. Joining: Longitudinal slip joints and 2 inch laps.
   5. Fittings: 0.02 inch thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 3/8 inch wide; .02 inch thick aluminum.

2.10 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

E. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

F. Adhesives: Compatible with insulation.

2.11 ELECTRIC HEAT TRACING

A. The self-regulating heater shall consist of two nickel-plated copper bus wires embedded in a radiation cross-linked semiconductive polymer core. The heater shall be capable of varying its heat output along its entire length, allowing the heater to cross over itself without overheating. The heater shall be covered by a polyolefin dielectric jacket rated 300 VAC at 105°C and a tinned copper braid (12 AWG equivalent wire size).

B. In addition to a tinned copper braid, the heating cable shall be covered by:
   1. A polyolefin outer jacket for protection from aqueous inorganic.

C. The heater shall operate on a line voltage of (110-120 or 208-277) VAC without the use of transformers.

D. The heating cable shall be suitable for use on metallic and nonmetallic piping. On nonmetallic piping, the cable shall be attached to the pipe with a parallel covering of aluminum tape.

E. For additional energy conservation, the heating cable shall be controlled by:
1. An adjustable pipewall sensing thermostat with a switch rating of 30/25 amps at 240/277 Vac.
2. Where the load of the heating cable exceeds the rating of the thermostat, the heating cable shall be controlled through an appropriately sized contactor by the control thermostat.

F. All heating cable core will be permanently marked with the manufacturer's identification number for traceability.

G. Acceptable products and manufacturers: FLX cable and accessories as manufactured by Thermon or approved equal.

H. Refer to the manufacturer's freeze protection design guide for design details, insulation requirements, maximum circuit lengths and accessory information.

I. Manufacturer shall demonstrate experience manufacturing and designing freeze protection systems with self-regulating heating cables.

J. Manufacturer's Quality Assurance Program shall be certified to the ISO 9001 Standard.

K. Heat tracing splicing kit shall be provided where required to connect multiple section of cabling.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify piping, equipment and ductwork has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - GENERAL

A. PVC piping covers for piping, equipment, etc. shall not be installed in spaces defined as plenums used for conveying air; such as ductwork plenums or return air ceiling plenums.

3.3 INSTALLATION - PIPING SYSTEMS

A. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Division 7 for penetrations of assemblies with fire resistance rating greater than one hour.

B. Multiple layers: Where multiple layers of glass fiber pipe insulation are required, inner layer shall not be provided with vapor barrier jacket.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, air separators and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, flanges, unions and valves with molded insulation of like material and thickness as adjacent pipe. Finish with PVC fitting covers.
4. Coil Termination Point: Insulate piping and associated components up to coil connection.

D. Piping Systems Conveying Fluids Above Ambient Temperature:
1. Insulate all parts of system not requiring routine maintenance including: Fittings, valves, strainers and air separators.
2. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
3. Insulate fittings, joints, flanges, unions and valves with molded insulation of like material and thickness as adjacent pipe. Finish with PVC fitting covers.
4. Coil Termination Point: For piping over 1” diameter, insulate piping and associated components up to coil connection. For piping 1” and smaller, terminate hot water piping at union connection to coil.

E. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
   a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
   b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

F. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer’s recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

G. Piping Exposed to View in Kitchen and other Finished Spaces: Finish all with 16 gauge aluminum jacket and fitting covers.

H. Piping installed at the exterior of the building such as Condenser Water Supply and Return and Non Potable Cold Water piping: Finish all with 16 gauge aluminum jacket and fitting covers.

I. Piping Jackets at the Exterior to Building: Finish with seams located at bottom of piping with lip to shed water.

J. Piping Exposed in AHU Pipe Enclosures (CHWS&R, HWS&R, etc.): Finish with PVC jacket and fitting covers.

K. All Piping in Mechanical Rooms / Boiler Rooms / Equipment Mezzanines less than 10 feet above finished floor: Finish with PVC jacket and fitting covers.

L. Refrigerant Piping Located at the exterior of the building: Finish all with PVC jacket and fitting covers.

M. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum jacket.

3.4 INSTALLATION - EQUIPMENT

A. Exposed Equipment: Locate insulation and cover seams in least visible locations.

B. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface.

C. Multiple layers: Where multiple layers of glass fiber insulation are required, inner layer shall not be provided with vapor barrier jacket.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids Above Ambient Temperature:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.

G. Chilled water pump impellers and suction diffusers: Insulate in two sections for ease of removal. Enclose insulation in galvanized sheet metal box constructed of two sections with gasketed flanges for ease of removal.

H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

J. Prepare equipment insulation for finish painting. Refer to Section 09 90 00.

3.5 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions.

B. For all ductwork located within the building envelope, insulation shall be rated at a minimum installed value of R6. For all ductwork located outside the building envelope, insulation shall be rated at a minimum installed value of R8.

C. Insulated ductwork conveying air below ambient temperature:
1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. Insulated ductwork conveying air above ambient temperature:
1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

E. External Glass Fiber Duct Insulation:
1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

F. Duct and Plenum Liner:
1. Adhere insulation with adhesive for 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

G. External Closed Cell Elastomeric Duct Insulation:
1. Adhere to clean oil-free surfaces with full coverage of adhesive.
2. Seal seams and butt joints with manufacturer’s recommended adhesive.
3. When application requires multiple layers, apply with joints staggered.
4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
5. Lift ductwork off trapeze hangers and insert spacers.

3.6 INSTALLATION – HEAT TRACING CABLE

A. Refer to the manufacturer's installation instructions and design guide for proper installation and layout methods. Deviations from these instructions could result in performance characteristics different than intended.

B. All installations and terminations must conform to the National Electrical Code and any other applicable national or local code requirements.

C. Circuit breakers supplying power to the heat tracing shall be equipped with 30 mA ground-fault equipment protection; 5 mA GFCI should not be used as nuisance tripping may result.

D. Piping shall be pressure tested prior to installation of heating cable. Thermal insulation shall not be installed until heating cable installation is complete and a megohmeter (megger) test has been passed (see Testing). Heattraced lines shall be insulated promptly after the heat tracing installation.

E. The insulation shall not be installed with staples. Insulation jackets should be closed with adhesive to avoid damage to the heating cable.

F. System shall be connected to power by the electrician (see Division 26-Electrical).

G. Heating cable shall be tested with a megohmeter (megger) between the heating cable bus wires and the metallic ground braid. While a 2,500 VDC megger test is recommended, the minimum acceptable level for testing is 500 VDC. This test should be performed a minimum of three times:
   1. Prior to installation while the cable is still on reel(s).
   2. After installation of heating cable and completion of circuit fabrication kits (including any splice kits) but prior to installation of thermal insulation.
   3. After installation of thermal insulation but prior to connection to power.

H. The minimum acceptable level for the megger readings is 20 megohms, regardless of the circuit length.

I. Results of the megger readings shall be recorded and submitted to the construction manager.

3.7 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Non Potable Cold Water Piping unless noted otherwise	P-1	All	1.0
Chilled Water Supply and Return Piping unless noted otherwise	P-1	1-1/4 inch and smaller 1-1/2 inch and larger	0.5 1.0

Chilled Water Supply and Return Piping in Unconditioned Spaces (i.e. Mechanical Rooms, Boiler Rooms, Penthouse, etc.)	P-1	1-1/4 inch and smaller 1-1/2 inch and larger	1.0 1.5
Chilled Water Supply and Return Piping in Pipe Enclosures serving AHU's	P-1	1-1/4 inch and smaller 1-1/2 inch and larger	1.0 1.5
Chilled Water Supply and Return Piping outside of the building All sizes shall be (2) layers with staggered seams.	P- 2	1-1/4 inch and smaller 1-1/2 inch and larger	1.0 2.0
Condensate Piping from Cooling Coils (Copper Piping)	P-1	All sizes	0.75
Refrigerant Piping – Suction Lines	P-2	Less than 1 inch 1 inch and larger	0.5 1.0
Refrigerant Piping – Liquid Lines and Hot Gas Lines	P-2	Less than 1-1/2 inch 1-1/2 inch and larger	1.0 1.5

B. Heating Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Heating Water Supply and Return unless noted otherwise	P-1	1-1/4 inches and smaller 1-1/2 inches and larger	1.5 2.0
Heating Water Supply and Return in Partitions in Conditioned Spaces	P-1	1-1/4 inches and smaller	1.0
Heating Water Supply and Return at Floor Penetrations Under Radiation Enclosures	P-1	1-1/4 inches and smaller	0.5
Heating Water Supply and Return Piping in Pipe Enclosures serving AHU's	P-1	1-1/4 inches and smaller 1-1/2 inches and larger	2.0 3.0
Heating Water Supply and Return Piping outside of the building	P- 2	1-1/4 inches and smaller 1-1/2 inches and larger	2.0 3.0
Steam Supply Piping	P-1	All sizes	2.5
Steam Condensate Piping	P-1	All sizes	2.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Chilled Water Air Separators	E-2	1.5
Chilled Water pump impellers and suction diffusers Each shall be constructed of two sections for ease of removal	E-3	2.0
Chilled Water - Misc. pipe mounted devices	E-1	1.0
Heating Water - Air Separators and other misc. pipe mounted devices	E-1	2.0

D. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE	INSULATION THICKNESS inches
Outside Air Intake Ducts and Plenums In Concealed Spaces	D-1	2.0 / Min R6
Outside Air Intake Ducts and Plenums In Exposed Spaces	D-2	2.0 / Min R6
Exhaust Air Plenums and Ductwork In Concealed Spaces between louver or hood (exterior envelope penetration) and motorized damper (includes RLA Relief air ducts also)	D-1	2.0 / Min R6
Exhaust Air Plenums and Ductwork In Exposed Spaces between louver or fan (exterior envelope penetration) and motorized damper (includes RLA Relief air ducts also)	D-2	2.0 / Min R6
Supply Ducts In Concealed Spaces	D-1	2.0 / Min R6
Supply Ducts In Mechanical Rooms, Boiler rooms, Penthouse and other spaces where the ductwork is exposed and susceptible to damage.	D-1	2.0 / Min R6
Return Ducts In Mechanical Rooms, Boiler rooms, Penthouse and other spaces which are not fully conditioned.	D-2	2.0
Supply Ducts installed concealed spaces where the temperature differential is greater than 40 degrees F	D-1	3.0 / Min R8
Supply Ducts installed in fully conditioned spaces and exposed below ceilings	N/A	N/A
Combustion Air Intake Ducts and Intake Plenums	D-2	2.0

All Air Handling Units: SA, RA and exhaust air ductwork for 20' of ductwork from ductwork connection at unit to each main and branch (30 feet away from unit's connection). Provide this insulation spec at main duct and all lateral ducts and branch ducts that are a distance 20 feet away. NOTE – thermal insulation required above is not required where acoustical lagging is provided.	D-3	2.0

Definitions:

1. Concealed spaces shall be defined as locations where ductwork is installed in soffits, ceiling plenums, shafts, etc

END OF SECTION

SECTION 230923

DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Control equipment.
2. Software.
3. Sensors and input devices.
4. Dampers, valves, actuators and output devices.
5. Variable frequency drives.
6. Copper tubing and gauges.
7. Trending data.

B. Related Sections:
1. Section 01 91 13 – General Commissioning Requirements
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI MC85.1 - Terminology for Automatic Control.

1.3 OVERVIEW

A. This specification defines the minimum equipment and performance requirements for a Direct Digital Control (DDC) Building Management System (BMS).

B. It shall be understood that the drawings and specifications describe the approximate locations of the work. Do not scale the drawings to determine exact positions and clearances. Obtain from Architect, Engineer or the Owner any dimensions not shown.

C. Details of construction and of workmanship where not specifically described herein or indicated on the drawings shall be subject to the Engineer's or Owner's approval. It is the intent of these specifications to provide complete systems, left in good working order, ready for operation, including necessary labor and materials, whether or not specifically shown on the drawings or mentioned herein.

D. Before submitting proposals, examine the specifications and all drawings relating to the work and become fully informed as to the extent and character of the work and the relation of the work to that of other Sections. Examine the drawings of other Sections to become familiar with all the problems and details of the building construction and to note conditions, which affect the work.

1.4 DESCRIPTION OF WORK

A. System shall be BACnet-compatible in accordance with ASHRAE 135.

B. Systems described herein are all field installed sensors and devices. Factory installed devices are acceptable providing the DDC Building Management System is the same company as the manufacturer of the HVAC equipment.

C. BMS shall operate from a workstation inside the facility provided by the Owner in coordination with their IT department.

D. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and master building controllers. All materials and equipment used shall be standard components, regularly manufactured and not custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.

E. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.

F. The BMS shall possess a modular architecture, permitting expansion through the addition of more Direct Digital Control Panels (DDCP's), Application Specific Controllers (ASC's), Terminal Equipment Controllers, sensors, actuators, and/or operator terminals.

G. Provide full DDC control of all HVAC equipment, as indicated per the sequence of operations and the input/output summary.

H. The Controls System Operator Workstation software shall be graphically oriented and shall be designed and implemented for use on the Internet and the Owner’s Intranet. All aspects of the Controls Systems Operator Interface shall be provided to operate through an IT industry standard Web Browsers such as Internet Explorer. The Web Browser based Operator Interface provided shall not require the procurement or licensing of any special or proprietary software from the Controls Contractor or its suppliers for the Controls Systems OWS.

1.5 WIRING

A. Installation of the entire building management system shall be by skilled electricians and mechanics, all of who are properly licensed, trained and qualified for this work.

B. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications.

C. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

D. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)

E. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.

F. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

G. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 10 ft intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 5 ft intervals or more often to achieve a neat and workmanlike result.

H. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

I. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

J. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.

K. Supervision and checkout of the system shall be by local branch engineers and technicians directly employed by the Control contractor.

L. Power wiring for the DDCP's, ASC's, and TEC's, shall be provided by the BMS contractor from the nearest power panel for this purpose.

M. Electrical wiring shall be performed by qualified electricians directly subcontracted by the BMS contractor.

1.6 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Drawings shall be submitted digitally.
1. Nomenclature of fans, pumps, etc shall match nomenclature on the contract documents.
2. Valve Schedule showing part number, description, configuration, actuator type, body and disc composition, pressure drop, and GPM.
3. Damper Schedule showing dimensions, opposed or parallel, function, and actuator type.
4. Schematic of each air handling system, hydronic system, etc., locating each control component on its respective unit with proper termination point identifiers (include legend). One schematic shall be included for each individual air handling system.
5. Each schematic shall show a chart detailing all hardware components used. The chart shall include:
   a. Schematic Control Symbol
   b. Quantity
   c. Manufacturer's Part Number
   d. Technical Sheet Reference
   e. Description of Part
6. Each Direct Digital Control Panel (DDCP) shall be detailed in the submittal to identify termination boards within each panel and termination of their respective field points. Each termination point shall define the point name and point description by each terminal within the field panel. Point names and descriptors

shall be consistent throughout the submittal on schematics, wiring diagrams, equipment lists, etc.

7. The Control manufacturer's technical reference sheets for each hardware component and application program shall be included in the submittal.

C. Shop Drawings: Indicate the following:
1. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
2. Connected data points, including connected control unit and input device.
3. System graphic displays showing monitored systems, data (connected and calculated) point addresses, and operator notations. Submit demonstration CD or web-link containing graphics.
4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
5. Description and sequence of operation for operating, user, and application software.
6. Use terminology in submittals conforming to ASME MC85.1.
7. Coordinate submittals with information requested in Section 23 09 93.

D. Points List: Provide a separate list of all system points. This list shall be used for sign-off by BMS contractor that each point is connected, programmed, functioning properly and mapped correctly to associated BMS graphics.

E. Product Data: Submit data for each system component and software module.

F. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

H. Samples:
1. Provide (1) sample of each type of space temperature sensor and carbon dioxide sensor to be installed for review by Owner.
2. Provide listing of all rooms where all space sensors are to be installed; indicating the type of sensor to be installed in each room for review by Owner.

1.7 QUALITY ASSURANCE

A. All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards.

B. Provide written approvals and certifications after installation has been completed.

C. Manufacturer must prove that he has been engaged in the production, installation and service of this type of equipment for at least five (5) years and has a fully equipped; factory trained and authorized service organization.

D. The system control contractor shall have been an authorized installing contractor for the manufacturer’s components for a minimum of (5) years.

E. Final determination of compliance with these specifications shall rest solely with the Owner and Engineer who will require proof of prior satisfactory performance.

F. For any equipment submitted for approval, the BMS contractor shall state what, if any, specific points of system operation differ from these specifications.

G. The BMS contractor shall continue to bear the liability for replacement of substituted equipment in the event that the equipment fails to perform as specified, or to meet approval of all authorities having jurisdiction, within twelve (12) months after beneficial use by the owner.

1.8 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.
2. Submit data specified in "Submittals" in final "Record Documents" form.

C. Operation and Maintenance Data:
1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
2. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.10 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 WARRANTY

A. Refer to Specification Section 01 78 30 - Warranties and Bonds.

1.13 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of control systems for one year from Date of Substantial Completion.

C. Furnish complete service of controls systems, including callbacks. Provide emergency call back service at all hours of the day for this maintenance period.

D. Furnish four complete inspections per year, one in each season, to inspect, calibrate, and adjust controls and components. Clean, adjust, and lubricate equipment. Submit written report after each inspection.

E. Repair or replace defective parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

F. Perform work without removing units from service during building normal occupied hours.

G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

H. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.14 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish, install and program four extra wall mounted space temperature sensors per owner/Engineer direction.

PART 2 PRODUCTS

2.1 DIRECT DIGITAL CONTROLS

A. Manufacturers: WebCTRL as represented by Automated Logic Corporation (ALC).

2.2 BUILDING MANAGEMENT SYSTEM

A. BMS shall consist of an information sharing network of stand-alone Direct Digital Control Panels (DDCP's/Controllers), Application Specific Controllers (ASC's), Terminal Equipment Controllers (TEC's) to monitor and control equipment per the sequence of operations and the input/output summary.

B. "Information sharing" shall be defined as: the function of each controller to exchange data on the network trunk with other controllers without the need for additional devices such as network managers, gateways or central computers.

C. "Stand-alone" shall be defined as: the function of each controller to independently monitor and control connected equipment through its own microcomputer.

D. All control devices will be electronic.

2.3 ADVANCED WORKSTATION (AWS)

A. General structure of workstation interaction shall be a standard client/server relationship with web server embedded in the server for browser only access. Server shall be used to archive data and store system database. The AWS shall support operation in a virtualized server environment. A single server license shall not restrict system size based on point count (BACnet or Integration).

B. Data Displays
1. Data displays shall render all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings, and wiring diagrams from as-built drawings.
2. Data displays shall render data using iconic graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, trendlog, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user.
3. Data display frame shall allow user to change all field-resident AWS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc., from any screen, no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.
4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic.
5. All displays and programming shall be generated and customized by the local use building management system (BMS) supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.
6. AWS shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. AWS shall include a library of equipment graphic components to assemble custom graphics. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.
7. A navigation tree for building, equipment and system diagnostic centric display organization shall be available from data display view. The tree navigation contents shall be customizable on a per-user and per-group basis.
8. Each display may be protected from viewing unless operator credentials have the appropriate access level. An access level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
9. Data displays shall have the ability to link to content outside of the BMS system. Such content shall include, but is not limited to launching external files in their native applications (for example, a Microsoft Word document).
10. A single system software license can support a minimum of 200 user accounts and web access.
11. Data displays shall support:
    a. Graphic items with custom geometry that offer both color gradient shading and variable opacity in scale to system variables, both analog and digital, and color range settings. For example, rooms on a floor plan

graphic can be made to indicate the space temperature by varying the color of that room.

b. Clear and custom geometry navigation buttons to provide intuitive navigation to system display or external URLs.
c. Graphic files in JPG, PNG, and GIF file types.
d. Viewing of up to 1,024 system data points (Analog, Binary, and/or Multi-state) in a single screen.
e. Customizable mouse-over tooltip information of graphic items or data points can be displayed. The tooltips can be turned on and off. The default setting is off.
f. Right click capability to directly access system functionality, such as Schedule, Trendlogs, and Alarms associated with a display object selected.
g. Automatic zooming to the screen size detected to maximize the size of the display to match screen display area available. The zoom capability can be enabled or disabled, default is enabled. The background color, if solid, will be used to flood fill the remaining screen background.
h. Supports user configurable embedded Data Viewer for a persistent trend log data view to accompany system data and graphic information on a single display.

C. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.
2. AWS shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID, User Name, and Password shall be shall support a minimum of 40 characters. All user information and passwords shall be stored in an encrypted form.
3. Each user shall be allowed individual assignment of only those control functions, menu items, navigation tree, and user-specific system start display, as well as restricted access to discrete BACnet devices to which that user requires access.
4. Users shall also have a set access level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct access levels for assignment to users.
5. The AWS Client shall include an Auto Logout feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.
6. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

D. Operator Activity Log

1. An Operator Activity Log that tracks all operator changes and activities shall be included with AWS. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation. Operator shall be able to print the Operator Activity Log display.
2. Log shall be gathered and archived to a hard drive on AWS as needed. Operator shall be able to export data for display and sorting in a spreadsheet.
3. System shall have the option to require user comment recording in the Operator Activity Log upon any system point change.

4. Operator Activity log shall be accessible via the Web Client for viewing, sorting, filtering, and Printing.

E. Scheduling
1. Format shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.
2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate access privileges.
4. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.
5. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.
6. Display of all three schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
7. Any displayed data that is changeable by the operator may be selected using the right mouse button and the schedule shall then be selectable on the screen. Selection of the schedule using this method shall allow the viewing of the assigned schedule allow the point to be scheduled.
8. Schedule editor shall support drag-n-drop events and holidays onto the schedule calendar.
9. Schedule editor shall support drag-n-drop events default to a two-hour period, which can then be adjusted by the user.
10. Schedule editor shall support drag-n-drop holidays default for OFF all day and can be edited for multiple-day holidays.
11. Schedule editor shall support the view of affected zones when adding or editing timed events of a schedule.
12. The web client shall have the ability to search a list of all scheduled points and zones to access the schedule calendar.
13. Schedule time blocks shall present schedule detail via mouse-over information.

F. Alarm Indication and Handling
1. AWS shall provide visual, printed, and email means of alarm indication. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID’s authorization level.
2. Web client shall display a persistent alarm state for the system regardless of the data view including points in alarm but not acknowledged, and points that have gone into alarm and returned to normal without being acknowledged.
3. Alarm History shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the AWS. Each entry shall include a description of the event-

initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.

4. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).
5. Web client shall support color-coded indication of current alarms as follows:
   a. Red indicator shows number of active alarms that have not been acknowledged.
   b. Yellow indicator shows number of alarms that are still active but have been acknowledged.
   c. Blue indicator shows number of alarms that have returned to normal but have not been acknowledged.
   d. Color-coded indicators, when selected by the user, navigate to a pre-filtered view of alarm history.
   e. Alarm history can be filtered by color-coded indicator states.
6. Alarm annunciation includes navigation link to a user-selected display or URL.
7. Any displayed data that is changeable by the operator may be selected using the right mouse button and the alarm shall then be selectable on the screen. Selection of the alarm using this method shall allow the viewing of the alarm history or allow the creation of a new alarm.

G. Trendlog Information

1. AWS shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System database shall be capable of storing up to 30,000 records before needing to archive data. Samples may be viewed at the web client. All trendlog records shall be displayed in standard engineering units.
2. For trending criteria, refer to Part 3 – Execution.
3. AWS shall be capable of trending on an interval determined by a polling rate, or change-of-value.
4. Users shall be able to add and edit trendlogs and the setup information. This includes the information to be logged as well as the interval at which it is to be logged. All operations shall be password protected. Viewing may be accessed directly from any and all graphics on which a trended object is displayed.
5. AWS shall be capable of using Microsoft SQL as the system database.
6. Any displayed data that is changeable by the operator may be selected using the right mouse button and the trendlog shall then be selectable from a menu on the screen.
7. Trending data shall include the following features:
   a. Software that is capable of graphing the trend-logged object data shall be included.
   b. Access and ability to create, edit and view are restricted to users by user account credentials
   c. Specific and repeatable URL defines the trendlog(s) views for browser bookmarking and email compatibility.
   d. Call out of trendlog value at intersection of trend line and mouse-over vertical axis.
   e. Trendlog or Energy log and companion logs can be configured to display on one of two independent vertical scales embedded in the display.
   f. Click zoom for control of data set viewed along either graph axis.

g. User-specifiable start and end dates as well as a fast scroll features that supports click zoom of macro scale view of the data for quickly finding data set based on visual signature.
h. User export of the viewed data set to MS Excel.
i. Web browser-based help.
j. Optional min/max ranges (Upper Control Limits, Lower Control Limits) for each value.

H. Energy Log Information
1. AWS shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.
2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
3. AWS operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
4. AWS shall display data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.
5. Web client shall display data in tabular format and graphical format. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

I. Demand Limiting
1. AWS shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator-selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.
3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.
4. AWS shall be able to display the status of each and every load shed program. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

J. Reports
1. AWS shall be capable of periodically producing reports of trendlogs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.

2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

K. Configuration/Setup
1. Provide means for operator to display and change system configuration. This shall include, but not be limited to system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.
2. The building management system (BMS) shall operate the user interface in any region and support varying languages and locale settings, without the addition of special software. Localization tools shall be commonly available open sourced or purchased products, manufacturer specific software shall not be used.
   a. The following localization capabilities shall be supported:
      1) Locale settings related to date, time and number formats
      2) Multiple left-to-right languages supported including Cyrillic languages
      3) On the fly locale change using browser language settings (multiple language and locale setting change)
      4) Default character encoding shall be UTF-8
      5) Each localized BMS element can be localized independently and operate autonomously

L. Field Engineering Tools
1. AWS shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.
2. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
3. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.
5. Field engineering tool shall include Device Manager for detection of devices connected anywhere on the BACnet network by scanning the entire network. This function shall display device instance, network identification, model number, and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer's hard drive. If needed, this file shall be downloaded to the appropriate controller using the mouse.
6. AWS shall automatically notify the user when a device that is not in the database is added to the network.
7. AWS shall include backup/restore function that will back up entire system to selected medium and then restore system from that medium. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.

8. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.

M. Workstation Hardware and Accessories:
   a. Provided by the Owner.

N. Software
   1. At the conclusion of the project, contractor shall leave with owner an electronic copy that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

O. Web Client
   1. BMS supplier shall provide an HTML5-based browser access to the AWS as part of standard installation. User must be able to access all displays of real-time data that are part of the AWS using a standard web browser. Web browser shall tie into the network through owner-supplied Ethernet network connection. The web client shall support a minimum of 200 users with a single license.
   2. Browser shall be standard version of Microsoft Internet Explorer v10.0 or later, Firefox v19.0 or later, Chrome v24.0 or later, and Safari v7.1.1 or later. No special vendor-supplied software shall be needed on computers running browser. Data shall be displayed in real-time and update automatically without user interaction.
   3. Web pages shall be automatically generated using HTML5 from the data display files that reside on the AWS. Any system that requires use of an HTML editor for generation of web pages shall not be considered.
   4. Access to the AWS shall utilize the same hierarchical security scheme as the AWS. User shall be asked to log on once the client makes connection to the AWS. Once the user logs on, any and all changes that are made shall be tracked by the AWS. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged on to the system.
   5. Shall provide User Session Management including the ability to view all connected user sessions to the web client, see how long they have been active/inactive for each unique session, and force log-out for any or all sessions.
   6. Shall provide menu-style navigation access to primary features, i.e. alarm history, trending, Search scheduled points and Zones, System Activity, User Session Management, and Top Display
   7. Web client shall, at a minimum, support the following tablets:
      a. Android platform:
         1) Google Nexus
         2) Samsung Galaxy Note
      b. Apple platform
         1) Ipad
         2) Apple Ipad Mini

2.4 BUILDING CONTROLLER

A. General Requirements
   1. BACnet Conformance
      a. Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.
      b. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All

proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2. Building controller shall be of scalable design such that the number of trunks and protocols may be selected to fit the specific requirements of a given project.
3. The controller shall be capable of panel-mounted on DIN rail and/or mounting screws.
4. The controller shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller.
5. The controller shall be capable of running up to six (6) independent control strategies simultaneously. The modification of one control strategy does not interrupt the function or runtime others.
6. The software program implementing the DDC strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a wide area network (WAN) or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.
7. Programming shall be object-oriented using control function blocks and support DDC functions. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.
8. The programming tool shall provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator's workstation or field computer.
9. Controller shall have 6,000 Analog Values and 6,000 Binary Values.
10. Controller IP configuration can be done via a direct USB connect with an operator's workstation or field computer.
11. Controller shall have at a minimum a Quad Core 996Ghz processor to ensure fast processing speeds.
12. Global control algorithms and automated control functions shall execute using a 64-bit processor.
13. Controller shall have a minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus to ensure high speed data recording, large data storage capacity and reliability.
14. Controller shall support two (2) on-board EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
    a. Ports are capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
15. Controller shall support two (2) ports—each of gigabit speed—Ethernet (10/100/1000) ports.
    a. Ports are capable of supporting various Ethernet protocols including, but not limited to BACnet IP, FOX, and Modbus.
16. All ports shall be capable of having protocol(s) assigned to utilize the port's physical connection.
17. The controller shall have at a minimum four (4) onboard inputs, two (2) universal inputs and two (2) binary inputs.
18. Schedules
    a. Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.
    b. Each building controller shall support a minimum of 380 BACnet Schedule Objects and 380 BACnet Calendar Objects.

19. Logging Capabilities
    a. Each building controller shall log as minimum 2,000 objects at 15-minute intervals. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
    b. Logs may be viewed both on-site or off-site using WAN or remote communication.
    c. Building controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.
    d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
20. Alarm Generation
    a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
    b. Each alarm may be dialed out as noted elsewhere.
    c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
    d. Controller must be able to handle up to 2,000 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.
21. Demand Limiting
    a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 1,200 loads using a minimum of two types of shed programs.
    b. Load shedding programs in building controller modules shall operate as defined in section 2.1.J of this specification.
22. Tenant Activity Logging
    a. Tenant Activity logging shall be supported by a building controller module. Each independent module shall support a minimum of 380 zones.
    b. Tenant Activity logging shall function as defined in section 2.1.K of this specification.

B. BACnet MS/TP
1. BACnet MS/TP LAN must be software-configurable from 9.6 to 115.4Kbps
    a. Each BACnet MS/TP LAN shall support 64 BACnet devices at a minimum.
    b. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. BACnet IP
1. The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the local area network (LAN).
2. Must support interoperability on WANs and campus area networks (CANs), and function as a BACnet Broadcast Management Device (BBMD).
3. Each controller shall support at a minimum 128 BBMD entries.
4. BBMD management architecture shall support 3,000 subnets at a minimum.
5. Shall support BACnet Network Address Translation.
6. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

D. Expansion Ports
1. Controller shall support two (2) expansion ports.
a. Combining the two on-board EIA-458 ports with fully loaded expansion ports, the controller shall support six (6) EIA-485 trunks simultaneously.
2. Expansion cards that mate to the expansion ports shall include:
a. Dual port EIA-485 card.
b. LON network card.

E. Power Supply
1. Input for power shall be as shown on the contract documents.
2. Optional rechargeable battery for shutdown of controller including storage of all data in flash memory.
3. On-board capacitor will ensure continuous operation of real-time clocks for minimum of 14 days.

F. Controller shall be in compliance with the following:
1. UL 916 for open energy management
2. FCC Class B
3. ROHS
4. IEC 60703
5. C-Tick Listed

G. Controller shall operate in the following environmental conditions:
1. -4 to 149 °F (-20 to 65 °C) without optional battery, or 32 to 122 °F (0 to 50 °C) with optional battery.
2. 0 to 95% relative humidity (RH), non-condensing.

2.5 CENTRAL PLANT AND AIR HANDLER APPLICATION CONTROLLERS

A. Provide one or more native BACnet application controllers for each air handler and provide native BACnet application controllers as needed for central plant control that adequately cover all objects listed in object list. All controllers shall interface to building controller through either MS/TP LAN using BACnet protocol, or Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. BACnet Conformance
1. Application controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.
2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Multi-state Values, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000 ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs with 12-bit resolution shall support either 0–10VDC or 0–20mA. Binary outputs shall have LED indication of status. Software shall include scaling features for analog outputs. Application controller shall include 20VDC voltage supply for use as power supply to external sensors.

1. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.
2. The position of each and every HOA switch shall be available system wide as a BACnet object property.

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal.

1. The following control blocks shall be supported:
    a. Natural Log
    b. Exponential
    c. Log base 10
    d. X to the power of Y
    e. Nth square root of X
    f. 5th Order Polynomial Equations
    g. Astronomical Clock (sunrise/sunset calculation)
    h. Time based schedules

E. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

F. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

G. Schedules

1. The controller shall support a minimum of 3 BACnet Schedule Objects and have a real time clock on board with battery backup to maintain time through a power loss.

H. Logging Capabilities

1. Controller shall support a minimum of 50 trendlogs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

I. Alarm Generation
1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

J. The controller processor shall be minimum 32-bit processor.

K. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

2.6 EXPANDABLE CENTRAL PLANT APPLICATION CONTROLLERS

A. General
1. Expandable application controller shall be capable of providing control strategies for the system based on information from any or all connected inputs. The program that implements these strategies shall be completely flexible and user-definable. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site though simple download are not acceptable. Changing global strategies using firmware changes is also unacceptable. Program execution of controller shall be a minimum of once per second.
2. Programming shall be object-oriented using control program blocks. Controller shall support a minimum of 500 Analog Values and 500 Binary Values. Each and every analog and binary value shall support standard BACnet priority arrays. Programming tool shall be provided with system and shall be the same tool that is used to program the building controller. All flowcharts shall be generated and automatically downloaded to controller. No re-entry of database information shall be necessary.
3. Provide means to graphically view inputs and outputs on each program block in real-time as program is executing. This function may be performed using the operator's terminal or field computer.
4. Controller shall have adequate data storage to ensure high performance and data reliability. Battery shall retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Battery shall be a field-replaceable (non-rechargeable) lithium type. Unused battery life shall be 10 years.
5. The onboard, battery-backed real-time clock must support schedule operations and trendlogs.
6. Global control algorithms and automated control functions should execute using 32-bit processor.
7. Controller shall include both onboard 10Base-T/100Base-TX Ethernet BACnet communication over UTP and shall include BACnet IP communication. In addition, controller shall include BACnet Point-to-Point (PTP) connection port.
8. The base unit of the controller shall host up to 8 expansion modules with various I/O combinations. These inputs and outputs shall include universal 12-bit inputs,

binary triac outputs, and 8-bit switch-selectable analog outputs (0–10V or 0–20mA). Inputs shall support 3K and 10K thermistors, 0–5VDC, 0–10VDC, 4–20mA, dry contacts and pulse inputs directly.

9. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.
10. The position of each and every HOA switch shall be available system wide as a BACnet object. Expandable central plant controller shall provide up to 176 discreet inputs/outputs per base unit.

B. BACnet Conformance
1. Central plant/AHU controller shall, as a minimum, support PTP, MS/TP and Ethernet BACnet LAN types. It shall communicate directly through these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between all supported LAN types. Controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.
2. Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Binary Input, Analog Output, Binary Output, Analog Value, Binary Value, Device, File, Group, Event Enrollment, Notification Class, Program, and Schedule object types. All necessary tools shall be supplied for working with proprietary information.
4. The Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on WANs and CANs, and function as a BBMD.

C. Schedules
1. Each central plant/AHU controller shall support a minimum of 50 BACnet Schedule Objects.

D. Logging Capabilities
1. Each controller shall support a minimum of 200 trendlogs. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator’s workstation.
2. Controller shall periodically upload trended data to system server for long-term archiving if desired.
3. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

E. Alarm Generation
1. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator’s terminal or off-site using remote communications.
3. Controller must be able to handle up to 200 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

2.7 TERMINAL UNIT APPLICATION CONTROLLERS

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

B. BACnet Conformance
1. Application controllers shall, as a minimum, support MS/TP BACnet LAN types. They shall communicate directly using this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements and support all BACnet services necessary to provide the following BACnet functional groups:
   a. Files Functional Group
   b. Reinitialize Functional Group
   c. Device Communications Functional Group
2. Please refer to Section 22.2, BACnet Functional Groups in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.8 VAV BOX CONTROLLERS—SINGLE DUCT

A. Provide one native BACnet application controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. BACnet Conformance
1. Application controllers shall, at a minimum, support MS/TP BACnet LAN types. They shall communicate directly through this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements.
2. Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Application controller shall include microprocessor driven flow sensor for use in pressure independent control logic. All boxes shall be controlled using pressure-independent control algorithms and all flow readings shall be in CFM (LPS if metric).

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using the same programming tool as Building Controller and as described in operator’s workstation section. All programming tools shall be provided as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operations for specific display requirements for intelligent room sensor.

F. On board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. Pre-calibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator's workstation, portable computers, and special hand-held field tools shall not be needed for field calibration.

G. Provide duct temperature sensor at discharge of each VAV box that is connected to controller for reporting back to operator's workstation.

2.9 SENSORS/INPUT DEVICES TO CONTROLLERS

A. All space temperature sensors, which are used, as inputs to the Controllers shall be the thermistor or RTD type. The range shall be 40 - 120 degrees F. at a factory calibration point of 77 degrees F. Accuracy shall be ± 0.5 degrees F at calibration point.
   1. Vandal resistant sensors located in locker rooms, mechanical rooms, toilet rooms, etc. shall be stainless steel plate type with override reset button.
   2. Sensors located in administrative areas, offices, etc. shall be wall mounted unless noted otherwise with LCD display, bias levers and override reset button.
      a. Bias lever shall allow temperature to be adjusted within a pre-programmed range (adjustable).
      b. Override time shall be set and in half-hour increments; maximum override time set through BMS (adjustable).
   3. Sensors located in waiting areas and corridors shall be wall mounted unless noted otherwise without display, or adjustment.
   4. Sensors located patient bays, recovery areas, prep areas, etc. shall be wall mounted unless noted otherwise without display. Provide bias levers and override reset button.
      a. Sensory shall provide relative humidity readings.
      b. Bias lever shall allow temperature to be adjusted within a pre-programmed range (adjustable).
      c. Override time shall be set and in half-hour increments; maximum override time set through BMS (adjustable).
   5. Sensors located operating rooms (OR's), OR corridor, and OR prep areas, etc. shall be wall mounted unless noted otherwise with LCD display. Provide bias levers and override reset button.
      a. Sensory shall provide relative humidity readings.
      b. Bias lever shall allow temperature to be adjusted within a pre-programmed range (adjustable).
      c. Override time shall be set and in half-hour increments; maximum override time set through BMS (adjustable).

B. Single point duct temperature sensors shall be the thermistor or RTD type. The range shall be 40 - 150 degrees F with a factory calibration point of 77 degrees F. Accuracy shall be ± 0.5 degrees F at calibration point. These sensors shall be used in unit discharge and return air ducts.

C. Averaging element sensors shall be the platinum element RTD type with 4 - 20 ma transmitters to eliminate any necessary calibration adjustment for wiring length. The range shall be 20 - 120 degrees F at a factory calibration point of 70 degrees F. Accuracy of the sensor at calibration point shall be ± 1.1 degrees F. These sensors shall be used in unit mixed air or preheat coil discharge sections.

D. Outside air temperature sensor shall be the platinum element RTD type with 4 - 20 ma transmitters to eliminate any necessary calibration adjustment for wiring length. The range shall be -58 - 122 degrees F and have accuracy at calibration point ± 0.5 degrees.

E. Low temperature detectors (freezestats) shall be auto reset, two-position snap acting. Capillary shall have minimum sensitive length of 20 feet and shall be installed in serpentine fashion downstream from coil it is protecting. Each square foot of coil shall be protected by a section of the capillary. Where large coil size or multiple coil construction exceeds the limit of coverage of one unit, provide additional units placed in series to that coil area coverage is maintained.

F. Humidity sensors shall be commercial grade with standard 4 - 20 ma outputs. The range shall be 0 -99% RH. Stated accuracy shall be + 5% RH minimum.

G. CO2 Sensors: Microprocessor based, with LCD display, demand control ventilation interfacing, self calibrating. Sensors shall use single or dual-beam absorption infrared diffusion technology (non-dispersive infrared), and shall have integral programming to perform automatic baseline calibration without user interface. The recommended manual recalibration period shall not be less than five years. Sensors shall meet or exceed the following specifications.
1. Operating conditions: 60oF to 90oF; 0 to 95% relative humidity, non-condensing
2. CO2 sampling method: diffusion or flow-through
3. CO2 measurement range: 0 to 10,000 ppm
4. Sensitivity: +10 ppm
5. Accuracy: +50 ppm from 0 to 2000 ppm, +5% of reading above 2,000 ppm
6. The sensors shall be provided with the manufacturer's recommended calibration kit. The kit shall include sufficient material to initially calibrate every sensor provided for the project. Combination temperature/CO2 sensors are acceptable (see paragraph A, above).

H. Carbon monoxide sensor (CO)
1. Standalone CO detector.
2. 24VAC power.
3. 4-20 ma output signal.
4. Two output relays
5. Wall mounted gas detector and CO snap in cartridge.
6. LED Displays for low alarm, high alarm, failure and power.

I. Water temperature sensors shall be well-mounted insertion liquid temperature sensor, platinum element with a 4 - 20 ma signal transmitted to the DDCP. The ranges used shall be appropriate with the application. The range applied for sensing hot water temperature shall be 70-220 degrees F and for sensing chilled and condenser water temperatures shall be 20-120 degrees F.

J. Differential Pressure Switches: The differential pressure range of the switch shall be selected to suit the application and shall have an adjustable set point. The switch shall have SPDT contacts rated at 9 amperes at 120 volt AC and be UL approved. The switch shall be mounted with the diagram in a vertical plan. The switch shall be capable of withstanding full system pressure on either side of the sensing element with atmospheric pressure on the other side, without damage to the switch or degradation of its calibration.

K. Temperature, Pressure, Flow and Level Transmitters: Transmitters shall produce a 4 to 20 mA output linearly proportional to the measured variable, with a minimum accuracy of .5% of the transmitter range. The range shall not exceed 200% of the measured variable's normal maximum value.

L. Duct (or System) Static Pressure Measuring Devices: Provide, where indicated, duct static measuring devices capable of continuously monitoring the duct or system static pressure it serves.
   1. The pressure range of the switch shall be selected to suit the application and shall have an adjustable set point and deadband. The switch shall have at least one SPDT contact rated at 9 amperes at 120 volt AC and be UL approved.
   2. The duct static traverse probe shall be of extruded aluminum construction and (except for 3/4" diameter probes with lengths of 24" or less) be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure, without need for correction factors, with an instrument accuracy of 0.5%.
   3. Pressure Transmitters shall be the 4 - 20 ma output type with zero and span adjustments. The range shall be 0-00.5", 0-1", 0-2", 0-5", or 0-10" w.c. as required by the application. Combined static error (non-linearity and hysteresis) shall be ± 1% of full range output. Transmitters shall be supplied to transmit a 4-20 ma signal to the DDCP for every flow measuring station and duct static pressure traverse probe.

M. Space pressure monitoring station – for AII rooms:
   1. Room pressure controller shall be designed to maintain a constant pressure differential. System shall be capable of reporting pressure, temperature, humidity, and ventilation.
   2. Continuously controls to design pressure setpoint by modulating a valve or damper
   3. Integrates into building automation systems via BACnet or Modbus.
   4. Color touch screen display provides visual indication of room status.
   5. Accepts keyswitch to change room mode to neutral/no isolation.
   6. TSI PresSura model RPC30 or approved equal.

N. Airflow Measuring / Monitoring Stations - Fan inlets with round cowlings:
   1. The measuring station shall not significantly impact fan performance or contribute to fan generated noise levels. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.
   2. Transmitter shall be 24 VAC power with 4-20 ma output signal. Transmitter shall have an accuracy of ±0.5% of Natural Span and be furnished with a built-in 3-way zeroing valve, user selectable square root function, and integral 3½ digit scalable LCD for display of measured process. The Transmitter shall be housed in a NEMA 12 steel enclosure with universal 1/8" FPT signal connection ports

O. Airflow Measuring / Monitoring Stations – Duct mounted, outside air hoods, exhaust hoods and all other applications:
   1. Probes shall be thermal dispersion airflow and temperature measurement device. Accuracy shall be 3% or better of actual flow over 0 to 5,000 fpm velocities. Each measurement device shall consist of one or more sensor probe assemblies. Multiple sensor housings shall be equally weighted and averaged by the transmitter prior to output. Provide stand-off mounting hardware when installing probes inside the casing of air handling equipment. Modify air handling unit hoods to provide laminar airflow across measuring station to guarantee 3% or better accuracy.
   2. Transmitter shall be 24 VAC power with 4-20 ma output signal. Transmitter shall include LCD for display.

P. Aquastats shall be pipe mounted, 24 VAC.

Q. Wall mounted switches shall be toggle type, 24 VAC.

R. Heat trace temperature sensors shall be bulb type sensor with 10’0” long capillary and 4-20 ma signal.

S. Current sensing relay shall be digital output.

T. Water leak detectors shall be probe type, 24 VAC; Dwyer WD3 with mounting bracket or approved equal. Provide with DPDT relay and audible alarm.

U. Audio/Visual Alarms shall be alarm indication station with visual alarm, audible alarm, silence button dry input contact and 24 VAC power.

V. Occupancy sensors shall be ceiling mounted, 24 VAC power, with two (2) dry contacts, programmable off time period and programmable sensitivity level. Sensors serving shop areas shall be dual technology (passive infra-red with ultrasonic noise) and provided with 120 volt / 1 phase power pack.

W. Glycol Refractometer (GR) shall be AFAB Enterprises Model PR-111, Misco Model M-111 or Hanna Instruments. Power supply shall be 120V, 1 phase or 24 VAC, 1 phase. BMS contractor shall provide branch circuit power to device. GR shall be provided with stainless steel sensing element, 4-20 mA output and 0-100% analog display meter. Provide adapters for varying pipe sizes. GR shall be calibrated over a 60ºF range for types of glycol and % of solution as shown on the drawings.

X. Space differential pressure transmitter / sensor shall be 24 VAC power, 0 to 10 VDC or 4 to 24 ma output signal, audio and visual local alarm, alarm output contacts and compatibility with Lonworks and BACNET.

2.10 CONTROL DAMPERS AND MOTORIZED DAMPERS

A. All dampers shall be thermally insulated and thermally broken or approved equal.

B. Extruded aluminum (6063T5) damper frame shall not be less than .080" thickness. Damper frame to be 4" deep. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts.

C. Blades to be extruded aluminum (6063T5) profiles, internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55. Blade and frame seals shall be of extruded silicone and be secured in an integral slot within the aluminum extrusions.

D. Maintenance-free bearings are to be composed of a Celcon inner bearing fixed to a 7/16" (11.11mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.

E. Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.

F. Modulating dampers (designated with “AO” shall be opposed blade action. Open/close dampers (designated with “DO”) shall be parallel blade action.

G. Leakage shall not exceed 3 cfm/ft² against 1" w.g. differential static pressure. Pressure drop of a fully open 48" x 48" damper shall not exceed .03" w.g. at 1000 fpm.

H. Dampers shall be made to size required without blanking off free area. Dampers shall be available as "Flanged to Duct" mounting type.

I. Damper Actuators shall be electronic type and shall be either fully proportional spring return or two-position spring return as described in the sequence of operation and as shown on the control drawings. Damper operators shall be located outside the air stream. Damper actuators shall be of sufficient size to operate their respective dampers effectively. End switches shall be provided for all actuators. BMS shall connect and monitor end switches as indicated on Mechanical Control Drawings, related mechanical drawings and Specification Section 230993.

2.11 CONTROL VALVES – DIGITAL SIGNAL

A. Control valves shall be 24VAC, two-position, spring-return, normally open with a maximum differential pressure of 60 PSIG

B. Spring return, electronic motor actuators shall position control valves. All valves shall have shutoff discs and V-ring packing. Valve sizes of 1/2 through 2 inches shall be furnished with screwed or soldered ends with stainless steel or bronze trim to suit the application. Flanged valves with bronze trim shall be furnished for sizes 2 1/2 inch and larger. Lug type butterfly valves with bronze discs and disc seals suitable for the medium and expected temperature range may be used for valve sizes of 5 inch or larger provided that the control signal for modulating valve applications employs both proportional and integral algorithms. The minimum rating for valve bodies shall be ANSI class 125.

C. The BMS contractor shall size each control valve to provide the proper flow rate at the available differential pressure, and shall include the Cv of each valve in his submittal.

2.12 CONTROL VALVES – ANALOG SIGNAL

A. The electronic actuator shall mount on the valve body and provide complete modulating control of the valve. The electronic actuator shall receive a 24 VAC floating control signal, 0-10vdc or 4-20ma to control the valve. Valves shall be bronze body with stainless steel trim. The minimum rating for valve bodies shall be ANSI class 125, Belimo or approved equal.

B. Valves 2 1/2 inches or less shall be globe valve style or ball valve produced for modulating control ("equal percentage valve"). Globe valves shall be bronze body, bronze trim, screwed bonnet, non-asbestos packing, renewable composition disc and bronze seat, Class 125, threaded or solder ends. Ball valves shall be bronze two piece body, blowout-proof stem, stainless steel ball with Teflon insert, Teflon seats and packing with solder or threaded ends

C. Valves 3 inches and over shall be globe valve style with iron body, bronze trim, bolted bonnet, non-asbestos packing, rotating plug-type disc with renewable seat ring and disc, Class 125, flanged ends.

2.13 VARIABLE FREQUENCY DRIVES/CONTROLLERS

A. Manufacturers: ABB ACH500 or approved equal as manufactured by Schneider Electric or Yasakwa.

B. DESCRIPTION
1. Enclosed variable frequency controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7.
2. Select unspecified features and options in accordance with NEMA ICS 3.1.

C. RATINGS
1. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
2. Operating Ambient: 0 degrees C to 40 degrees C.

D. DESIGN
1. Employ microprocessor-based inverter logic isolated from power circuits.
2. Employ pulse-width-modulated inverter system.
3. Design for ability to operate controller with motor disconnected from output.
4. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.

E. PRODUCT OPTIONS AND FEATURES
1. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
2. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
3. Volts Per Hertz Adjustment: Plus or minus 10 percent.
4. Current Limit Adjustment: 60 - 110 percent of rated.
5. Acceleration Rate Adjustment: 0.5 - 30 seconds.
6. Deceleration Rate Adjustment: 1 - 30 seconds.
7. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.
8. Input/Output Signals:
   a. 4-20 mA input central signal.
   b. 4-20 mA output feedback signal.
   c. Contact closure for general alarm output.
9. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
10. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
11. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
12. Manual Bypass: Furnish contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.
13. Disconnecting Means: Include integral fused disconnect switch on the line side of each controller.

F. FABRICATION
1. Wiring Terminations: Match conductor materials and sizes indicated.
2. Enclosure: NEMA 250, Type 1.
3. Finish: Manufacturer's standard enamel.

PART 3 EXECUTION

3.1 INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units where not subject to excessive vibration. Obtain approval on locations from owner's representative prior to installation.

B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operations.

C. Extend 120 VAC power to control transformers at locations shown on the drawings. Provide control transformers and low voltage wiring to all control components including sensors, actuators, etc.

D. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.

E. Identify all equipment and panels. Provide permanently laminated plastic labels at all devices and panels.

F. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections—sized to suit pipe diameter without restricting flow.

G. Glycol Refractometer (GR) shall be installed in 1" bypass line with isolation valves and manual type balance valve. Bypass line shall be installed form pump suction to pump discharge.

H. Install outdoor air temperature sensors on north wall complete with sun shield at manufacturer's recommended location.

I. Control components shall be calibrated against actual measurement of flow, temperature, humidity, etc. as recorded in conjunction with Specification Section 230593.

3.2 PROGRAMMING

A. Provide sufficient internal memory for all controllers to ensure specified sequence of operations, alarming, trending, and reporting requirements are achieved. BMS manufacturer shall provide a minimum of 25% spare memory capacity for future use.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

C. Software Programming: Provide programming for individual mechanical systems to achieve all aspects of the sequence of operation specified. It is the BMS manufacturer's responsibility to ensure all mechanical equipment functions and operates as specified in sequence of operations. Provide sufficient programming comments in controller application software to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

D. BMS Operator's Interface
   1. At the Operator Workstations, provide color graphics for each piece of mechanical equipment depicting sufficient I/O to monitor and troubleshoot operation. Additionally, provide individual floor plans of the building allowing an operator to quickly view the overall floor plan area for any out of tolerance conditions that may need addressing. These standard graphics shall depict all points dynamically as specified in the points list and/or indicated in sequence of operation.
   2. The BMS manufacturer shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data, and any third party software installation and integration required for successful operation of the operator interface.
   3. As part of this execution phase, the BMS manufacturer shall perform a complete test of the operator interface.

E. State of the art technology
   1. Dashboard shall be based on HTML5 technology for user interface development to allow users to view the dashboard on all mobile devices such as iPads, Android Tablets, in addition laptops and desktops, through openly available HTML5 compatible versions of web browser's like Firefox, Safari, Chrome and Internet explorer.
   2. The user interface shall interact with robust dashboard database which is based on MSSQL.
   3. Dashboard database shall gather the measured data from the Building Automation System.
   4. The system shall also be capable of accessing weather data from web based or onsite weather data.
   5. The data collected would include consumption and demand of various resources like electricity, water, PV, car charging feeds and gas usage.

F. Dashboard Database Architecture and integration with BAS system
   1. The Dashboard database shall be a separate database with ability to interact with MSSQL database of Building Automation System. It shall be possible to install BAS database and dashboard database on different PCs or servers. Dashboard uses trended historical data accessed from a BAS system which is on the same network as the Dashboard computer.
   2. Dashboard database shall store and maintain all the configurations made in the dashboard along with all the analysis data. This data should be stored with in customer's server.
      a. The dashboard system samples and records all the manually entered data as well as the data collected by the system
      b. The Dashboard shall interface with the BAS system for accessing the historical data from the BAS system SQL database.
      c. Dashboard shall support manual entry of historical data to be included in data.
      d. Dashboard shall collect the data from SQL Server.
         Data collected by the dashboard should reside in local server at client facility. Dashboard which requires the data to be sent to server located remotely outside the client facility is not acceptable.
      e. Proprietary data management and storage formats are not allowed.

G. Weather Data:
1. Weather data is available on various web based sources like yahoo and any web based local weather station. This weather data can be fetched and used to calculate the HDD and CDD values which can be used for further analysis.
   a. The Energy Dashboard tool shall be able to receive web based weather data for use in the database from local weather sources to use in a weather regression calculation.
   b. The Energy Dashboard tool must also calculate the actual site Heating Degree Day, Cooling Degree Day, Heating Degree Hour and Cooling Degree Hour data and record the actual site HDH, CDH, HDD and CDD data into the energy database.

H. Baseline Construct
1. Baselines are the measured/estimated consumptions of a building for various energy types during an observation period. These can be used as reference consumptions to compare with the current consumption for performance analysis.
   a. Baselines may be entered manually into a preformatted spreadsheet and shall be imported into the energy dashboard.
   b. Historical data collected by the dashboard shall be used as baseline.
   c. Baseline year can be selected manually.

I. Minimum Recourses monitored by ATC Contractor shall be:
1. Water meter usage
2. PV electricity generated
3. Overall Electricity Used
4. Charging Feeds
5. Gas Usage

J. Graphical Display
1. Dashboard shall support line, Bar, pie charts.
2. Graphical data shall be available for POP for all buildings, for all energy types and adjusted and unadjusted data.
3. This module shall allow construction of a page within specifically defined portions which include:
   a. Graphical formats like jpeg, bitmap, png.
   b. Video files.

K. Export:
1. All charts/graphs shall be printable or exported to the excel spreadsheet

L. Latest Internet Technology
1. Dashboard shall be built on HTML5, the latest internet technology, which allows users to view the dashboard on all mobile devices such as iPads, Android Tablets, etc. without installing any special applications.

3.3 TRENDING DATA

A. Trendlog Information: BMS shall periodically gather historically recorded data per paragraphs in Part 2 – Products above.

B. Permanent Trending: System shall save data every 15 minutes for all components associated with the chiller plant, boiler plant, air handling units and ERV's.

C. Start-up Trending: At the start of the project (Substantial Completion), BMS shall save data every 15 minutes for all components connected to the BMS for one full year.

D. Data shall be saved and stored locally for 30 days and shall be readily accessible. After 30 days, data shall be permanently stored and automatically archived.

3.4 IDENTIFICATION OF HARDWARE AND WIRING

A. BMS manufacturer to coordinate labeling nomenclature with mechanical equipment manufacturer and other contractors.

B. All field wiring and cabling shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information for troubleshooting, maintenance, and service purposes.

C. At each control panel and controller, provide as-built drawing (maximum size 11x17) inside each controller listing each terminal point and descriptive information for troubleshooting, maintenance, and service purposes.

D. Identify control panels and controllers with minimum 1-cm letters on laminated plastic nameplates.

E. Identify relays with P-touch type labeler.

F. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.5 SYSTEMS TURN-OVER

A. Schedule work under the provisions of Division 1.

B. Upon completion of the project, check, validate, and calibrate, where required, all controllers, controlled devices, valves, actuators, auxiliary devices, relays, etc. provided under this section

C. Coordinate work with balancing contractor in respect to calibration, balancing at varying conditions, etc. Contractor shall be on site when all balancing is occurring.

D. Upon completion of the installation, the Contractor shall start-up the system and perform all necessary testing and run diagnostics to ensure proper operation. An Acceptance Test in the presence of the Owner’s Commissioning Agent shall be performed. The acceptance test shall consist of a point-to-point check to insure proper operation of all system components.

E. Contractor shall provide a report indicating devices checked, status, date, follow-up status, etc. Report shall be submitted prior to Functional Testing by the Owner and/or Commissioning Agent.

F. Problems which occur shall be corrected in an appropriate fashion under warranty. Any such occurrence shall not void previous approval; however, the Control Contractor shall be responsible to attend to, and remedy, such items within the warranty period. Appropriate logs, schedules, and reports shall be maintained to reflect these items and their redress.

3.6 TRAINING/OWNER'S INSTRUCTIONS

A. The Control Contractor shall provide two (2) copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the system.

B. The Contractor shall instruct the owner's designated representative in these procedures during the start-up and test period. The duration of the instructions is to be conducted during normal working hours and shall be no less than forty (40) hours.

C. The instructions shall consist of both hand-on and classroom training at the job site. Operational questions, which can be answered over the telephone, will be handled at no additional cost and will not count toward the forty hours of formal training.

D. Demonstrate operation and maintenance procedures.

E. Furnish services for manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of boilers. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date. Training shall be recorded and made available to Owner on electronic media.

END OF SECTION

SECTION 230993

SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes sequence of operation for:
1. General Devices
2. Utility Metering
3. Domestic hot water and pumps.
4. Ductless Split AC Units
5. Chillers and Primary chilled water systems.
6. Hot Water Boiler Plant.
7. Secondary Pumping Systems.
8. Air handling units.
9. Fans.
10. Radiation
11. VAV Boxes
12. Steam Boiler Plant.
13. Steam Humidifiers
14. Duct mounted smoke dampers.
15. Dryer Exhaust
16. Pressure controls.
17. Outdoor air conditions monitoring.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 09 23 - Direct-Digital Control System for HVAC: For equipment, devices, system components, and software to implement sequences of operation.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate mechanical system controlled and control system components.
1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
2. Submit flow diagrams for each control system, graphically depicting control logic.
3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
4. Coordinate submittals with information requested in Section 23 09 23.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 CONTROL DEVICES

A. All devices and sensors shall be adjustable. BMS shall display setpoints and actual conditions of all control devices and position of all actuators at the central personal computer (PC).

B. Wall switches noted herein shall be provided and installed by BMS contractor unless noted otherwise.

3.2 GENERAL DEVICES

A. All setpoints shall be adjustable unless noted otherwise.

B. All alarms shall be displayed at the operator central PC / workstation.

C. Variable Frequency Drives: BMS shall control start/stop of each VFD and shall monitor a general alarm contact at the VFD. If the VFD is in alarm mode, an alarm shall be activated at the central PC. BMS shall control speed of each VFD and monitor speed feedback.

D. Alarms: BMS shall monitor alarms as shown on the drawings. If a device is in alarm mode, an alarm shall be activated at the central PC. If space temperature is not maintained for 15 minutes (adjustable) an alarm shall be generated. If any device input signal is 10% higher or lower than setpoint (adjustable), an alarm shall be generated. All alarms shall be capable of being displayed remotely through remote workstations, smart devices, etc. Contractor shall coordinate with Owner as to which alarms shall be displayed remotely.

E. Alarms: BMS shall monitor each commercial freezer and refrigerator in the building. If an appliances is in alarm mode, an alarm shall be activated at the central PC. Typical for total or five appliances.

F. Fire Alarm: BMS shall monitor general alarm input signal. In addition, BMS shall monitor carbon monoxide signals from the fire alarm system for the rooms listed below. If BMS receives an alarm signal form one of these spaces, BMS shall provide alarms and SOP as listed below under independent carbon monoxide sensor SOP.
1. Boiler Room.

G. Independent Carbon Monoxide Sensors: BMS shall also monitor sensors independent of the fire alarm systems in the spaces listed below.
1. Boiler Room: If levels rise above setpoint, boilers, water heaters and chillers shall stop. Also, respective exhaust fan shall start and makeup air damper shall be open. Manual reset shall be required.

H. Filter Differential Pressure Transmitters: BMS shall monitor DPT’s and alarm if the differential pressure is above setpoint.

I. Space Differential Pressure Transmitters / Sensors: BMS shall monitor space sensors as shown on the drawings.

J. Carbon Dioxide at Exterior of the Building: BMS shall monitor and record carbon dioxide levels.

K. Leak Detector: If a detector is in alarm mode, the BMS shall shut down the respect fan, AC unit, VRF, etc. and an alarm shall be activated at the central PC.

L. Electric heat trace: BMS shall monitor analog signal from temperature sensor. If temperature is below 50F, BMS shall active electric heat trace. If temperature drops below 40F, an alarm shall be activated at central PC

M. Emergency Generator: BMS shall monitor operations of the generator and automatic transfer switches.

N. Lighting Control Panel Interface: BMS shall have capability to send a signal to the panel to indicate the panel should be in “special mode / override mode”. Provide an icon on the Central PC to allow user to activate this mode of operation (on/off toggle with time out).

3.3 UTILITY METERING

A. BMS shall monitor the electric meter at the main CT cabinet output.

B. Usage shall be recorded in a spread sheet format showing usage of each meter by day and compiled for each month and each year. Also, provide chart to have visual indication of usage throughout the year. Format of spread sheet and chart shall be reviewed and approved by Owner.

3.4 DOMESTIC HOT WATER AND PUMPS

A. Heat Pump Scheduling: Water heater on-off shall be controlled per a time of day schedule and shall be activated during occupied modes.

B. Domestic Hot Water Recirculating Pump: Pump shall be controlled per a time of day schedule and shall be activated during occupied modes.

3.5 DUCTLESS SPLIT AC UNITS

A. BMS shall monitor temperature independent of unit’s sensor. If temperature rises above 85F, BMS shall send an alarm to central PC.

B. BMS shall monitor lead detector in the secondary drain pan. If sensor detects leak, BMS shall shut down the AC unit and send an alarm to central PC

3.6 CHILLERS AND PRIMARY CHILLED WATER (CHW) PUMPING SYSTEMS

A. Operation of Chillers. Chiller Plant shall be enabled when the outside air temperature rises above 70°F (adjustable). Minimum ON/OFF times will prevent short-cycling of chillers and pumps. When chiller plant is enabled, lead secondary chilled water pump shall start (see Secondary Pumping Systems Description below).
   1. When a chiller is enabled, respective primary chilled water pump shall start and control valve shall open. Chiller shall not start until flow is proven through respective flow switches. If flow status is not proven, lead chiller shall not be

energized, lag chiller shall be energized and an alarm shall be activated at the central PC. Pumps are equipped with VFD's for balancing purposes only purposes.

2. Chillers shall be sequenced as required to maintain desired set point through a lead/lag array. Alternation of chiller lead/lag designation shall be based on operator defined run times. BMS shall monitor secondary chilled water flow rates and temperatures and chiller control panel for demand to start and stop lag chiller.
3. Each chiller shall stage through its internal controls to maintain chilled water supply setpoint. Chiller shall monitor CHW return temperature to determine staging.
4. Shut down: When chiller is de-energized, respective pumps shall continue to run for 5 minutes and then turn off. Pumps shall not stop until confirmation that respective chiller's compressor has shut down (chiller stop confirmation).
5. CHW supply temperature setpoint shall be reset based upon position and demand at each CHW valve. If no zone is in the maximum cooling position, the CHW supply temperature setpoint is decreased. This reset function is based on the following operator changeable variables. They are:
6. The length of time between reset adjustments.
7. The decrease in CHW supply temperature setpoint that is desired when the CHW valve its maximum open position.
8. The increase in CHW supply temperature setpoint that is desired when none of the CHW valves are in a maximum open position.
9. Demand for dehumidification.
10. BMS shall monitor the generator main ATS switch for status. Upon activation of emergency generator the chiller control panel shall be commanded to reduce to maximum of 70% load. The corresponding primary pumps shall be commanded to the same limited load.

3.7 BOILERS AND BOILER PRIMARY HOT WATER (HW) PUMPING SYSTEMS

A. The BMS contractor shall be responsible for installation and wiring of the Boiler Manufacturer Control Panel, Outdoor Sensors, Supply and Return Temperature Sensors, Individual Boiler Supply and Return Temperature sensors, and interlock wiring of the primary pumps and individual boiler isolation valves.

B. Boiler plant shall be allowed to operate (enable / disable) when OA temperature is below 65F.

C. BMS shall interface with controls listed below and shall be capable of reading and displaying the follow points from the boiler’s BMS interface:
1. Enable / disable output signal
2. Boiler status feedback – on/ off
3. Burner operating status – on/off.
4. General alarm output signal
5. Hot water supply temperature
6. Hot water return temperature

D. Once the hot water system flow is established, the BMS shall enable the Boiler Manufacturer Control Panel via the BACnet communication interface. The BMS shall monitor the boilers status and alarms via the communication interface, and monitor the dry contact alarm at the central Boiler Control Panel. The BMS contractor shall be responsible for installation and wiring of the Boiler Manufacturer Control Panel, Outdoor, System Supply and Return Temperature, and Individual Boiler Supply and Return

Temperature sensors, and interlock wiring of the primary pumps and individual boiler isolation valves.

E. Once enabled, the boiler manufacturer control panel will command the isolation valves and primary pumps, and enable and modulate the boilers in sequence based on its on outdoor air reset curve (adj.) to maintain supply water temperature at the reset setpoint.

F. The BMS shall monitor boiler room CO. If either gas is detected, the BMS shall command the combustion air dampers open, and disable the boiler control panel via the BACnet interface. Fan serving the boiler room shall start.

G. The BMS shall monitor hot water supply and return temperatures at locations shown on the floor plans independent form the boiler controls.

H. The BMS shall monitor outdoor temperature and humidity via its own sensors and display at the central PC.

I. Lead hot water pump shall start per sequences of operation described above. BMS shall monitor downstream hydronic differential pressure transmitters compared to user defined setpoints and modulate the pump VFD in order to maintain desired setpoints. VFD ramp-up and VFD ramp-down timing shall be user defined.

J. Designation of lead and standby pump shall be automatically alternated based on user defined run times or day of the week.

K. When the pump is enabled, the pump VFD status determines if the motor is operating. After an operator definable feedback time delay, if there is an indication that the pump is not operating, the standby pump shall be enabled and an alarm shall be generated. Conversely, if status is detected while pump is turned off, a separate alarm shall be generated.

3.8 SECONDARY PUMPING SYSTEMS (CHILLED WATER AND HOT WATER)

A. Lead hot water pump or lead chilled water pump shall start per sequences of operation described in other sections of this specification. BMS shall monitor downstream hydronic differential pressure transmitters compared to user defined setpoints and modulate the pump VFD in order to maintain desired setpoints. VFD ramp-up and VFD ramp-down timing shall be user defined.

B. The s operating setpoint at the differential pressure transmitters shall be set based on values determined during Testing, Adjusting and Balancing. The operating setpoint shall automatically be reset by BMS to a lower value based upon demand at control valves. The user shall be able to lock the output signal to the pump VFD (“manual override”).

C. Designation of lead and standby pump shall be automatically alternated based on user defined run times or day of the week.

D. When the pump is enabled, the pump VFD status determines if the motor is operating. After an operator definable feedback time delay, if there is an indication that the pump is not operating, the standby pump shall be enabled and an alarm shall be generated. Conversely, if status is detected while pump is turned off, a separate alarm shall be generated.

E. Additional Alarms: If the differential pressure remains 25% higher or lower at all the transmitters serving a hydronic system for 5 minutes, an alarm shall be activated at the central PC.

F. BMS shall monitor the generator main ATS switch for status. Upon activation of emergency generator the secondary chilled water pumps shall be commanded to a maximum of 70% load.

3.9 AIR HANDLING UNITS (AHU)

A. Unoccupied Mode:
1. Outside air, exhaust air and relief air dampers shall be closed.
2. Return air dampers shall be open.
3. Fan motors shall be deactivated.
4. When unit is signaled to stop, BMS shall slowly ramp down the fan speed. Once fans are at 10% speed, (where required) shall start to close.
5. BMS shall raise the zone temperature cooling setpoint to 85°F and drop the zone temperature heating setpoint of 65°F. If two or more zones are calling for heating or cooling the fans shall cycle on. When the call for heating or cooling is satisfied the fans shall be deactivated.
6. Chilled water and hot water valves shall be closed.
7. Freezestat (25F setpoint) and temperature sensor (35F setpoint) within the unit's casing shall be monitored during unoccupied mode. If temperature drops below setpoint of either device, the main heating valve shall be fully open, fans shall be de-activated and an alarm shall be activated at the central PC.
8. At units where duct mounted smoke detectors are installed outside of the envelope of the building: When unit is off or in unoccupied mode, unit shall cycle on to maintain minimum duct temperature of 40F at the duct mounted return air and supply air temperature sensors.

B. Occupied Mode:
1. The zone will calculate how long it will take to return from its unoccupied state to its occupied setpoint based on the heating or cooling capacity and the outside air temperature. The zone will then adjust its effective setpoint at the time necessary in order to ensure the desired zone conditions at occupancy.
2. The system will not start more than 4 hours before a scheduled occupancy.
3. When BMS has signaled a unit to start, the smoke dampers shall open first. Once the dampers are fully open, the fans shall start.
4. BMS shall track the supply fan's accumulated runtime. When runtime exceeds 10,000 hours, the controller will generate a runtime expiration message.
5. Fans shall operate continuously. Speed of duplex fans shall operate in unison.
6. Energy recovery motors shall be energized
7. Outside air and relief air dampers shall be at minimum open positions. Coordinate setpoints of motorized dampers serving outside air and relief air dampers with air balancer.
8. BMS shall monitor airflow at the outside air AFMS and shall modulate the OA damper to maintain setpoint.

C. Supply Air and Return Air Fans – VFD / Static Pressure Control
1. BMS shall modulate the supply and return fan VFD's with a reverse acting static pressure PID to maintain the duct static pressure at the static pressure setpoint (1.5" w.c.). The static pressure setpoint shall be reset based upon demand at VAV boxes (see SOP below). When cooling is activated, the fan VFD shall not be allowed to drop below a speed setting that will produce a flow rate equal to the total of the minimum flow settings of all the VAV boxes served

by the respective unit. Each unit shall be served by multiple duct mounted static pressure sensors. The operating setpoint at the pressure transmitters shall be set based on values determined during Testing, Adjusting and Balancing.

2. The user will be able to lock the output signal to the supply fan VFD.
3. If the supply static pressure remains 25% higher than setpoint for 1 minute, an alarm shall be activated at the central PC.
4. BMS shall generate an alarm if the supply static pressure remains 25% lower than minimum setpoint for 5 minutes. This alarm will not be enabled until the supply fan has been running for 2 minutes.

D. Duct Static Pressure Setpoint Optimization: Fans shall operate continuously and modulate to maintain the duct static pressure setpoint. The duct static pressure setpoint is sent by the BMS and is reset per the optimization sequences of operation listed below:

1. When any VAV damper is more than 75% (adj.) open, the supply fan discharge duct static pressure setpoint shall be reset upward by 0.1 in W.C. (adj.), at a frequency of 15 minutes (adj.), until no damper is more than 75% open or the static pressure setpoint has reset upward to the system maximum duct static pressure setpoint or the AHU variable-frequency drive is at the maximum speed setting.
2. When all VAV dampers are less than 65% (adj.) open, the supply fan discharge duct static pressure setpoint shall be reset downward by 0.1 in W.C.(adj.), at a frequency of 15 minutes (adj.), until at least one damper is more than 65% open or the static pressure setpoint has reset downward to the system minimum duct static pressure setpoint or the AHU variable-frequency drive is at the minimum speed setting.
3. The control bands, setpoint increment values, setpoint decrement values and adjustment frequencies shall be adjusted to maintain maximum static pressure optimization with stable system control and maximum comfort control.
4. The BMS shall have the capability to allow the operator to exclude “problem” zones that should not be considered when determining the optimized setpoint.
5. The BMS shall also read the status of the supply air static pressure sensor and display the active duct static pressure reading on the status screen.
6. The BMS shall have the ability to identify, and display to the user, the VAV box that serves the Critical Zone (that is, the zone with the most wide-open VAV damper). This information shall update dynamically as the location of the Critical Zone changes based on building load, and duct static pressure setpoint optimization control.

E. Exhaust Air Static Pressure Control

1. When the fans have flow, the AHU controller will modulate the exhaust fan VFD’s (in unison where served by two fans) with a reverse acting static pressure PID to maintain the duct static pressure at the static pressure setpoint (1.0" w.c.). The static pressure setpoint shall be reset based upon demand at VAV boxes. The fan VFD shall not be allowed to drop below a speed setting that will produce a flow rate equal to the total of the minimum flow settings of all the VAV boxes served by the respective unit.
2. The user will be able to lock the output signal to the fan VFD.
3. If the supply static pressure remains 25% higher than setpoint for 1 minute, an alarm shall be activated at the central PC.
4. BMS shall generate an alarm if the supply static pressure remains 25% lower than minimum setpoint for 5 minutes. This alarm will not be enabled until the supply fan has been running for 2 minutes.

F. Fan Control:
1. When called to run, the fan will run for a minimum of 5 minutes.
2. When the fan cycles off, it will remain off for a minimum of 5 minutes.

G. Alarm Conditions:
1. If a freezestat trips, the hot water chilled water valve at the respective unit shall be fully open, fans shall stop, outside air damper shall be fully closed and an alarm shall be activated at the central PC.
2. Current sensing relays/VFD feedback: If fan has been signaled to start and feedback from respective relay or VFD does not indicate the fan has started after 30 seconds, unit shall be shut down and an alarm shall be activated at the central PC. Conversely, if fan on status is detected while the fan is turned off, a separate "Hand" alarm shall be activated at the central PC.
3. Damper end switches: If end switch does not indicate respective damper is open after 30 seconds, unit shall be shut down and an alarm shall be activated at the central PC. Conversely, if a damper is indicated open, a separate "Hand" alarm shall be activated at the central PC.
4. Duct mounted smoke detectors: When a detector is in alarm mode the fire alarm system shall be notified, respective fans shall be de-energized and an alarm shall be activated at the central PC.
5. The controller will generate an alarm if the zone temperature remains 4°F higher than its cooling setpoint for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
6. The controller will generate an alarm if the zone temperature remains 4°F lower than its heating setpoint for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
7. The controller will generate an alarm if the discharge air temperature remains higher than 120°F with a hysteresis of 5°F for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
8. The controller will generate an alarm if the discharge air temperature remains lower than 45°F with a hysteresis of 5°F for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.

H. Supply Air Temperature Setpoint Control
1. BMS will run a cooling setpoint optimization algorithm and a heating setpoint optimization algorithm simultaneously.
    a. The initial cooling setpoint will be 54°F, with a minimum of 49°F and a maximum of 72°F.
    b. If any zones are still calling for cooling at the end of a 5 minute period, the setpoint algorithm will respond by lowering the setpoint by 1°F for every zone requesting cooling.
    c. If no zones are still calling for cooling at the end of a period, the setpoint algorithm will respond by raising the setpoint by 1°F.
    d. The cooling setpoint algorithm will not adjust the cooling setpoint by more than 2°F in any period.
    e. The initial heating setpoint will be 82°F with a minimum of 72°F and a maximum of 85°F.
    f. If any zones are still calling for heating at the end of a 5 minute period, the setpoint algorithm will respond by raising the setpoint by 2°F for every zone requesting heating.
    g. If no zones are still calling for heating at the end of a period, the setpoint algorithm will respond by lowering the setpoint by 1°F.

h. The heating setpoint algorithm will not adjust the heating setpoint by more than 4°F in any period.

2. BMS shall determine the AHU supply air temperature setpoint based on the number of heating requests and cooling requests the AHU is receiving.
   a. If there are more cooling requests than heating requests coming into the AHU, or if there is the same number of heating requests as cooling requests, the AHU controller will use the cooling setpoint.
   b. If there are more heating requests than cooling requests coming into the AHU, the AHU controller will use the heating setpoint.
   c. When the BMS switches from the heating setpoint to the cooling setpoint, the setpoint control algorithm will ramp from the heating setpoint to the cooling setpoint at a rate of 1°F/minute.
   d. When the BMS switches from the cooling setpoint to the heating setpoint, the setpoint control algorithm will ramp from the cooling setpoint to the heating setpoint at a rate of 1°F/1.5 minute.
3. The user will be able to override the supply air temperature setpoint.

I. Heating Control
1. If the outside air temperature is less than 65°F with a 2°F hysteresis and the outside air temperature is valid, BMS will allow heating based on outside air conditions.
2. If the outside air temperature reading is not valid, BMS will still allow heating.
3. Upon a call for heating, dampers at energy recovery units shall be modulated to increase flow rate through the energy recovery section and reduce flow rate at the energy recovery's bypass. Energy recovery modules shall be the first stage of heating
4. Upon a further call for heating, BMS shall modulate the hot water valve to maintain temperature setpoints if cooling has been off for at least 5 minutes.

J. Cooling Control
1. If the outside air temperature is greater than 50°F with a 2°F hysteresis and the outside air temperature is valid, the AHU controller will enable cooling based on outside air conditions.
2. If the outside air temperature reading is not valid, the AHU controller will still enable cooling.
3. Upon a call for cooling, BMS shall modulate the chilled water valve to maintain temperature setpoints if heating has been off for at least 5 minutes.

K. Economizer Control
1. BMS will allow economizer cycles to be activated based on outside air conditions if the return air temperature and enthalpy is greater than the outside air temperature and enthalpy with a hysteresis of 5°F, the outside air enthalpy is less than 22 Btu/lb with a hysteresis of 2 Btu/lb, the outside air temperature is less than 65°F with a hysteresis of 2°F, and the outside air readings are valid.
2. If the outside air readings are not valid, BMS will disable the economizer. The user will be able to enable the economizer if the outside air readings are not valid.
3. When economizer cycles are activated, energy recovery motors shall stop and energy recovery bypass dampers shall open.
4. An economizer PID will modulate the economizer/ventilation dampers and relief air/exhaust fans between minimum setpoint and 100% to maintain the zone temperature at 2°F below the zone temperature cooling setpoint if heating has

been off for at least 5 minutes. The relief air fans and exhaust fans shall and activated.

a. The user will be able to adjust all PID parameters (P, I, and D gains, loop bias, and loop interval).
b. The user will be able to lock the economizer damper position.
c. The controller will limit the signal change sent to the economizer to 1% every 2 sec. when increasing.

5. The controller will limit the signal change sent to the economizer to 1% every 2 sec. when increasing.
6. If the mixed air temperature drops below 45°F, the AHU controller will begin to close the economizer to protect the coil. The controller will continue to close the damper linearly until the temperature drops to 40°F, when the economizer/ventilation damper will be 100% closed.
7. If the AHU loses flow or the freezestat trips, the AHU controller will close the economizer dampers.
8. The AHU controller will generate an alarm if the mixed air temperature remains lower than 45°F for 5 minutes with a 5°F hysteresis. This alarm will not be enabled until the supply fan has been running for 30 minutes.
9. The AHU controller will generate an alarm if the mixed air temperature remains higher than 90°F for 5 minutes with a 5°F hysteresis. This alarm will not be enabled until the supply fan has been running for 30 minutes.

L. Outside Air – Demand Control Ventilation: AHU's with VAV boxes

1. The AHU outdoor-air damper shall be controlled to deliver required outdoor airflow at all load conditions. The outdoor airflow setpoint shall be determined according to ASHRAE Standard 62.1-2004, Equation 6-8 and Appendix A. The actual outdoor airflow shall be sensed at the outdoor air intake.
2. The BAS shall include a time-of-day schedule to indicate whether a zone is normally occupied or unoccupied. When the schedule indicates that the zone is normally unoccupied, the required outdoor airflow for the zone (Voz) shall be zero. When the schedule indicates that the zone is normally occupied, the required outdoor airflow for the zone shall equal the design outdoor airflow (Voz-design, based on design occupancy), unless the zone is equipped with an occupancy sensor and/or a carbon dioxide (CO2) sensor.
3. For those zones equipped with an occupancy sensor, the required outdoor airflow for the zone (Voz) shall be continuously determined based on whether people are present or not. When the occupancy sensor indicates that people are present in the zone, the required outdoor airflow shall equal the design outdoor airflow (Voz-design). When the occupancy sensor indicates that no people are present in the zone, the required outdoor airflow shall equal the "occupied standby" outdoor airflow (Voz-standby).
4. For those zones equipped with a CO2 sensor, the required outdoor airflow for the zone (Voz) shall be continuously calculated.

3.10 ERV SECTIONS (AHU-3 ONLY)

A. Heating Mode: If the outside air temperature is less than the economizer changeover and the discharge air temperature is less than the discharge air temperature setpoint the following shall occur:

1. The supply and exhaust fans shall operate as sequenced above.

B. Stage 1 Free Heat:

1. The energy recovery plate shall be enabled.
2. The outside air (plate) by pass damper and the exhaust air (plate) bypass damper shall modulate so as to maintain the discharge air temperature setpoint.

3. The outside air damper shall modulate to their minimum outside airflow CFM.
4. The hot water control valve shall modulate closed.

C. Stage 2 Heating:
1. The energy recovery plate shall be enabled.
2. The outside air (plate) bypass damper shall close.
3. The exhaust air (plate) bypass damper shall close.
4. The outside air damper shall modulate to their minimum outside airflow CFM.
5. The hot water control valve shall modulate so as to maintain the discharge air temperature setpoint.

D. Heating - General
1. Upon a call for heating with the outside air is between 65°F and 40°F, BMS shall modulate the hot water valve, with the face and bypass damper full open to the coil, to maintain temperature setpoints if cooling has been off for at least 5 minutes.
2. Upon a call for heating with the outside air below 40°F outside air, the hot water valve shall be fully open and the face and bypass damper shall be modulated to maintain temperature setpoint if cooling has been off for at least 5 minutes.
   a. The user will be able to lock the signal to the hot water valve.
   b. The user will be able to lock the signal to the face and bypass damper.
3. Energy Recovery Modules - Frost Control: When outside air temperature is below unit's individual specific setpoint, bypass damper at the outside air side of the energy recovery module shall modulate open. If unit does not have a damper at the outside air, relief air/exhaust air bypass damper at the energy recovery module shall modulate open. Dampers shall modulate to maintain discharge air temperature setpoint.

E. Energy Plate Frost Protection Control
1. During the cold winter months, frost formation on the energy recovery plate is a possibility. Frost formation can restrict or reduce the air flow across the energy plate. To prevent frost build up on the plate, the Delta controller shall monitor the outside air temperature, if the entering outside air temperature is less than the "Frost Control Setpoint" the controller shall initiate "De-Frost Mode". When in the "De-Frost Mode" the following shall occur:
2. The energy recovery plate shall be enabled.
3. The outside air (plate) bypass damper shall modulate to ensure that the exhaust air temperature is at or above the frost control setpoint.
4. The outside air dampers and the recirculation damper shall modulate so as to maintain the discharge air temperature setpoint.
5. The exhaust air (plate) bypass damper shall be closed.
6. The hot water control valve shall modulate so as to maintain the discharge air temperature setpoint.

F. The temperature below which frost will begin to accumulate on heat exchanger surfaces is referred to as the frost threshold temperature. It is a function of outdoor temperature and indoor relative humidity. The following table lists typical frost threshold temperatures over a wide range of indoor air temperatures and relative humidity. Frost control is not required until outdoor air temperatures are below the threshold.

FROST THRESHOLD TEMPERATURE (°F)				
INDOOR AIR RH%	INDOOR AIR DRY BULB TEMPERATURE (°F)			
	70°F	72°F	75°F	80°F
20	-14	-13	-11	-8
30	-3	-2	-1	3
40	5	7	9	11
50	12	13	15	18
60	18	19	21	26

G. Cooling Control
1. If the outside air temperature is greater than 50°F with a 2°F hysteresis and the outside air temperature is valid, the AHU controller will enable cooling based on outside air conditions.
2. If the outside air temperature reading is not valid, the AHU controller will still enable cooling.
3. Upon a call for cooling, BMS shall modulate the chilled water valve, to maintain temperature setpoints if heating been off for at least 5 minutes.

H. Cooling Mode with Energy Recovery
1. If the outside air temperature is greater than the economizer changeover setpoint and the outside air temperature is greater than the return air temperature the Delta controller shall control the AHU as follows:
2. The supply and exhaust fans shall operate as sequenced above.
3. The energy recovery plate shall be enabled.
4. The outside air (plate) bypass damper shall close.
5. The exhaust air (plate) bypass damper shall close.
6. The outside air damper shall open to their minimum outside airflow CFM.
7. The recirculation damper shall modulate to its corresponding position.
8. The chilled water valve shall modulate so as to maintain the required supply air temperature setpoint.

3.11 FANS.

A. All Fans: BMS shall monitor the operation or failure (fan status) through a current sensing relay switch. For fans with variable frequency drives (VFD), BMS shall monitor fan status through an alarm output contact at the VFD. If fan has been signaled to start and feedback from the relay or VFD does not indicate the fan has started after 30 seconds, fan shall be shut down and an alarm shall be activated at the central PC. If damper end switches do not indicate respective dampers are open, fan shall be shut down and an alarm shall be activated at the central PC. Conversely, if status is detected while the fan is turned off or a damper is indicated open, a separate "Hand" alarm shall be generated.

B. All fans shall be programmed to operate or allow to be operated per individual time of day program.

C. Lab Exhaust Fans (LEF's): Fans shall be monitored for failure by both DPT and current sensing transformer. If in alarm mode, local audio visual alarm shall be activated and alarm shall occur at central PC.

1. Fan Serving Grossing Room: Fan shall operate continuously during all occupied hours.
2. Fan Serving Airborne Infection Isolation Room: Fan shall operate upon activation of room pressure control system. See section below.

3.12 RADIATION

A. Radiant Ceiling Panels: Upon a drop in space temperature below sensor setpoint, respective heating valve shall open in order to maintain desired space temperature setpoint. Radiation control for areas served by VAV boxes shall be sequenced together with the respective VAV box valve in order to maintain desired space temperature setpoint.

B. Cabinet Unit Heater/Unit Heater: Upon a drop in space temperature below sensor setpoint, respective heating valve shall open and fan shall be energized subject to aquastat sensing hot water at the supply branch piping. Temp sensors shall be analog input signals to BMS. Control wiring shall be low voltage, not line voltage. Fan shall not start until aquastat senses hot water.

3.13 VAV BOXES (STANDARD).

A. Occupied Mode
1. When zone temperature rises above its cooling setpoint and cool air is available from the AHU, a cooling PID algorithm will modulate the control damper between the minimum occupied airflow and the maximum design cooling airflow until the zone is satisfied.
2. When the zone temperature is between the cooling setpoint and the heating setpoint, the zone controller will maintain the minimum occupied airflow, providing no less than the minimum required zone ventilation.
3. When zone temperature falls below its heating setpoint, a heating PID algorithm will modulate open the heating valve to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the heating PID algorithm can modulate the control damper between the greater of the minimum occupied airflow or the minimum heating airflow and the maximum design heating airflow until the zone is satisfied.
4. Where more than one space temperature sensor serves a VAV box, the temperatures shall be averaged with absolute minimum –maximum setpoint programmed to override the average temperature.

B. Night Setback / Unoccupied Mode: When the zone is unoccupied, the zone controller will raise the cooling setpoint to 85°F, drop the heating setpoint to 65°F, and drop the minimum required airflow to 0 CFM. Space temperature sensors shall have an override button to change the VAV box from unoccupied to occupied mode for 3 hours.

C. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics. Airflow setpoints (minimum, maximum and heating mode) shall be displayed on the graphic for each individual VAV box.

D. Hot Water Coils: See sequences below.

E. Alarms
1. An alarm will be generated if the space temperature remains 4°F higher than its cooling setpoint or 4°F lower than its heating setpoint for 15 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
2. An alarm shall be generated if the airflow reading is 20% below or above setpoint.
3. For all VAV boxes with hot water coils, temperature sensor at the discharge of the VAV box shall be monitored for high and low temperature conditions. An alarm shall be generated if the supply air temperature is 10°F below or above setpoint.

F. Pressure Control:
1. VAV box serving Airborne Infection Isolation (AII) Room shall be modulated by local room pressure controller directly. Space shall be controlled to -0.03" space pressure differential. The BMS shall modulate the hot water heating coil and radiant panels to maintain space temperature as indicated in other sequences of operation.

3.14 VAV BOXES (OPERATING ROOMS)

A. BMS shall include occupancy sensors at the Operating Rooms. When an operating room is not occupied the BMS via the room's dedicated VAV box shall reduce airflow to approximately half of the maximum design airflow (actual setpoint shall be adjustable).

B. Each room shall have two occupancy sensors to provide redundancy. Also, each room shall be served by a labeled, wall mounted "HVAC Override" button at the entrance to the room. If the over-ride button is pushed the HVAC system shall automatically switch from unoccupied mode to occupied mode of operation.

C. Occupied to unoccupied mode: When both occupancy sensors indicate the room is unoccupied, airflow in the room shall begin to reduce after a preset, adjustable time period. After a delay of 15 minutes, the airflow shall begin to gradually reduce to the lower airflow. The time period to adjust the airflow from maximum design to the lower unoccupied flow rate shall be set for 10 minutes (adjustable).

D. A temperature sensor in the space shall temporarily override the unoccupied mode of operation. If space temperature rises above setpoint, the VAV box shall modulate open; increasing airflow to maintain temperature setpoint. As space temperature is satisfied, the VAV box shall modulate back to the unoccupied airflow position.

E. Unoccupied to occupied mode: If either one of the occupancy sensors indicates the room is occupied or the HVAC Override button is activated, airflow in the room shall immediately begin to increase back to the occupied mode airflow rate. The time period to adjust the airflow from minimum design to the higher occupied flow rate will be set for 5 minutes (adjustable). The airflow, space temperature and humidity shall "settle out" after another 5 minutes.

F. BMS shall monitor airflows at each VAV box and shall adjust output signal to maintain correct airflow setting.

G. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics.

Airflow setpoints (minimum, maximum and heating mode) shall be displayed on the graphic for each individual VAV box.

H. Monitor Space DP: Per FGI, minimum .01" W.C. Thus, setpoint of .015" (.01" low / .02" high).

3.15 VAV BOXES (WITHOUT HOT WATER COILS)

A. BMS shall monitor airflows at each VAV box and shall adjust output signal to maintain correct airflow setting (constant volume).

B. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics. Airflow setpoints shall be displayed on the graphic for each individual VAV box.

3.16 STEAM BOILER PLANT.

A. BMS shall enable the steam boiler control system upon when any recovery bay, operating room, or connected space registers a relative humidity below 30% (adjustable).

B. Boiler manufacturer's control panel shall modulate boiler output to maintain common header steam pressure setpoint.

3.17 STEAM HUMIDIFIERS

A. Interface with BMS combination temperature/humidity sensor and interlock to electronic/DDC controlled steam control valves so that the humidifier is modulated, as required, to maintain the desired relative humidity in the space (30%RH, adjustable), subject to the high limit reset action of the duct humidistat (provided by the ATC Contractor). The high limit sensor shall override the output to the humidifier control valve to limit the duct relative humidity to 85% RH (adj.). When there is no flow, the air flow switch (provided by the ATC Contractor) shall close the valve by spring action. Duct mounted humidistats shall have replaceable sensor tips.

B. For Operating Rooms: The controlling humidistat shall be a room mounted sensor for each humidifier, located as directed by the Architect.

C. For Recovery Area: The space humidistats shall be averaged for the zone.

D. The humidifier valve shall be closed during cooling season whenever the cooling coil control valve is open. Whenever the outside air temperature is <40°F and the chilled water valve is open (cooling coil freeze protection sequence), the humidifier shall operate in its normal mode as described above.

3.18 DUCT MOUNTED FIRE/ SMOKE DAMPERS

A. BMS shall monitor status of the air handling unit (AHU / DOAS) served by duct mounted smoke damper.

B. When a unit is signaled to stop, BMS shall close all smoke dampers served by this unit. When a unit is signaled to start, BMS shall open respective smoke dampers.

C. At each smoke damper, BMS shall monitor end switch indicating damper open/close status. If a unit has been signaled to start and feedback from respective end switches

does not indicate respective dampers are open after 30 seconds, an alarm shall be activated at the central PC. Conversely, after 30 seconds, if feedback indicates a damper is open when a unit is signaled to stop, an alarm shall be activated at the central PC.

D. Operation of each smoke damper shall also be controlled by fire alarm system. Refer to Electrical Drawings and Specification Section 28 3100

3.19 DRYER EXHAUST

A. The commercial clothes dryers are specified each with a dedicated dryer exhaust fan and manufacturer's stack pressure controller. The manufacturer's controller will vary exhaust fan flow based on dryer operation.

B. The BMS shall monitor the status of each dryer and exhaust fan using a current sensing relay. The BMS shall alarm should any dedicated fan not interlock and operate in conjunction with the corresponding dryer.

3.20 PRESSURE CONTROLS

A. At the Airborne Infection Isolation (AII) room (Room 1211) provide space differential pressure sensor with digital display outside room.
   1. Display shall include audible and visual alarm if negative pressure setpoint (-0.03") is not maintained.
   2. System shall be monitored by the BMS and provide global alarm.

3.21 OUTDOOR AIR CONDITIONS MONITORING

A. Functional Control
   1. Carbon Dioxide at Exterior of the Building: BMS shall monitor and record carbon dioxide levels.
   2. The controller shall monitor outside air temperature and humidity and calculate the outside air enthalpy, and will make these values available to the system.
   3. If the outside air temperature sensor indicates a reading lower than -25°F with a hysteresis of 10 or higher than 225°F with a hysteresis of 10 the controller will make the alternate outside air temperature sensor available to the system. If the sensor still indicates these readings after 5 minutes, the controller will generate a sensor failure alarm.

B. Temperature History
   1. Once the controller has established communication with the system after any interruption in communication, it will record a temperature history for the system.
      a. At 12:05 am every night, the controller will reset the high and low daily temperature peak recorders for the next day. The reset signal will last no longer than 5 seconds.
      b. When the high and low daily temperature peak recorders are reset for the first day of each month, the high and low month-to-date peak recorders will also be reset.
      c. When the high and low month-to-date peak recorders are reset for January, the high and low year-to-date peak recorders will also be reset.

3.22 ALARM NOTIFICATION

A. Events and alarms shall be indicated on the appropriate equipment graphics page viewable and with automatic display updates available at the central server level. The graphic display will indicate an alarm condition by showing the appropriate object in red on the graphic display.

B. Alarms and events shall be displayed on the Event Log Page viewable and with automatic display updates available at the central server level. Date and time of occurrence shall be recorded.

C. Alarms and events shall be transferred out of the automation system to other network services for remote notification to devices such as: Printers on the customer's network, e-mail systems, voice mail systems, paging systems, local alarms, or other reporting actions, depending on user configuration. Contractor shall coordinate with the Owner with programming and wiring remote alarms and trouble shooting them for accuracy.

3.23 TRENDING

A. All I/O points shall be linked to a trend log.
   1. BMS shall record a trend sample every 10 minutes on each of the trend objects.
   2. The controller will save the most recent 144 samples of each trended point in the control module for viewing or printing.
   3. The user will be able to enable or disable trending of any of the points listed. Points marked with an asterisk will automatically be trended in the default configuration.
   4. For the first year of operation, the system will trend and record all data at 10 minute increments which can then be backed up on CD's.
   5. A dedicated trend log page shall be setup to permanently monitor and record all indoor and outdoor conditions as follows (per State of CT HPB requirements): Temperature, humidity, relative humidity, dewpoint, CO2.

3.24 COMMISSIONING

A. Engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 23 08 00.

B. Verify that equipment is installed and commissioned as per requirements of Section 23 08 000 and manufacturer's written instructions.

C. Complete installation and startup checks and functional tests according to Section 23 08 00 and manufacturer's written instructions.

D. Operational Test: After electrical and control systems have been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the start up procedure.

E. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

SECTION 232113

HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Heating water piping, above ground.

B. Chilled water piping, above grade.

C. Chilled water piping, buried.

D. Equipment drains and over flows.

E. Unions and flanges.

1.2 RELATED SECTIONS

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

1.3 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
3. ASME B31.9 - Building Services Piping.
4. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B32 - Standard Specification for Solder Metal.
4. ASTM B75 – Standard Specification for Seamless Copper Tube.
5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
6. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
7. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
8. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
9. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
10. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

11. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
12. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
13. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
14. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
15. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
16. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
17. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
18. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
19. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
20. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
21. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot-and Cold-Water Distribution Systems.
22. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

1.4 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and Grooved coupling couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

1.5 SUBMITTALS

A. Shop Drawings: Indicate layout of piping system, including equipment, critical dimensions, and sizes.
1. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Grooved coupling style or series number.

B. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.

C. Test Reports: Indicate results of piping system pressure test.

D. Welders' Certificates.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves equipment and accessories.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with applicable authority for welding hanger and support attachments to building structure.

C. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

1.8 QUALIFICATIONS

A. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience.

B. 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.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M., black steel with plain ends; welded and seamless, Grade B.
   1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
   2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.
   3. 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.

B. Steel Pipe, grooved joints: ASTM A53/A53M, black steel with grooved ends.
   1. Fittings: ASTM A536 ductile iron, or ASTM A53 forged steel or fabricated from carbon steel pipe, grooved ends designed to accept Grooved coupling standard or AGS “W” series couplings.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: STM A536 ductile iron, enamel coated, compatible with steel piping sizes, rigid or flexible type.
         1) Rigid Type: 2 inch through 12 inch: “Installation ready” rigid coupling with offsetting, angle pattern bolt pads designed for direct ‘stab’ installation onto grooved end pipe without prior disassembly of the coupling, no torque requirement and Grade “EHP” EPDM gasket.
         2) Rigid Type: 14 inch through 24 inch: AGS grooves, wide housing key with flat bolt pads. Grade “E” EPDM FlushSeal® gasket.
         3) Flexible Type: 2 inch through 24” inch: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.
      b. Grade “E” EPDM Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
      c. Grade “EHP” EPDM Gasket: Elastomer composition for operating temperature range from -30 degrees F to 250 degrees F
      d. Accessories: Steel bolts, nuts, and washers.

2.2 COPPER PIPE AND FITTINGS

A. Drawn-Temper Copper Tubing, solder joints: ASTM B88, Type K, L, or M as specified in part 3 for application.
   1. Fittings:
      a. ASME B16.22, solder wrought copper.
   2. Prohibited Tee Connections: Mechanically extracted collars with notched and dimpled branch tube (T-Drill) fittings are prohibited.
   3. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

B. Drawn-Temper Copper Tubing, press-seal joints: ASTM B88, Type L or M as specified in section 3 for application.
   1. Press Fittings: IAPMO PS 117, ANSI LC1002, NSF61-G
   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.

2.3 BURIED PIPING

A. Manufacturer: Perma-Pipe Poly-Therm or approved equal.

B. For pipe sizes 2” diameter and less, carrier piping shall be Type L copper tubing with 95-5 tin-antimony solder joints.

C. For pipe sizes larger than 2” diameter, carrier piping shall be Schedule 40 carbon steel with welded joints.

D. Insulation shall be 1” thick polyurethane foam.

E. Outer jacket shall be filament sound, polyester rein / fiberglass reinforced composite directly applied to the insulation.

2.4 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
1. Ferrous Piping: Class 150 malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with soldered.
3. Dielectric Connections:
a. Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
b. Waterway fitting with zinc electroplated steel or ductile iron body, male thread, grooved, or plain end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:
1. Ferrous Piping:
a. Class 150 forged steel, slip-on flanges.
b. Grooved joint flange adapter, flat face, for direct connection to ANSI Class 125 and 150 flanges. For direct connection to ANSI Class 300 flanges
c. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
2. Copper Piping:
a. Class 150, slip-on bronze flanges.
b. Grooved joint flange adapter, flat face, for direct connection to ANSI Class 125 and 150 flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, chilled water piping, above ground, 2-inch and smaller, shall be the following:
1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and press-seal joints.

B. Hot-water heating piping, chilled water piping, above ground, 2-1/2 inch and larger shall be any of the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
2. Schedule 40 steel pipe, grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Chilled water piping, below ground; factory insulated product.

D. Makeup-water piping installed aboveground shall be the following:
   1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.2 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

3.3 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install pipe hangers and supports in accordance with Section 23 05 29.

3.5 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection size, location, and invert are as indicated on Drawings.

B. Establish elevations of buried piping with not less than four feet of cover.

C. Establish minimum separation from other service piping in accordance with code.

D. Remove scale and dirt on inside of piping before assembly.

E. Excavate pipe trench in accordance with Section 31 23 16 31 23 17 .

F. Install piping in accordance with ASME B31.1 ASME B31.9.

G. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not per manufacture’s recommendations. Coordinate with Division 31 specifications.

H. Install pipe on prepared bedding.

I. Route pipe in straight line.

J. Install piping specialties in accordance with Section 23 21 16.

K. Install pipe to allow for expansion and contraction without stressing pipe or joints.

L. Install valves at locations indicated on Drawings in accordance with other specification sections.

M. Install plastic ribbon tape continuous over top of pipe; coordinate with Section 31 specifications.

3.6 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Install Work in accordance with Owner’s guidelines.

B. Route piping parallel to building structure and maintain gradient.

C. Install piping to conserve building space, and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.

F. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

G. Install pipe identification in accordance with Section 23 05 53.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.

J. Slope hydronic piping and arrange systems to drain at low points.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

L. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 90 00.

M. Install valves with stems upright or horizontal, not inverted.

N. Insulate piping and equipment; refer to Section 23 07 00.

3.7 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.

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.

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. 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.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

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 joint piping systems: Install in accordance with the manufacturer's guidelines and recommendations.
1. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
2. A factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
3. Use roll sets or cut groovers compatible with the pipe material and wall thickness per manufacturer’s installation instructions.

I. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer’s installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) recommended by the manufacturer. Contractor shall be trained on the use and installation of the system by manufacturer’s representative.

3.8 FIELD QUALITY CONTROL

A. Comply with Division 1.

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." Pressure test for press-seal fittings shall not exceed 85 psi. If there is a significant drop in pressure, the system shall be walked to check for un-pressed fittings. Should an un-pressed fitting be located, the pressure should be released from the system and the un-pressed fitting shall be pressed.
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.

E. Test hydronic piping systems in accordance with ASME B31.9.

F. Pressure test to identify un-pressed fittings: Utilizing air or water, the system shall be pressurized, not to exceed 85 psi. If there is a significant drop in pressure, the system shall be walked to check for un-pressed fittings. Should an un-pressed fitting be located, the pressure should be released from the system and the un-pressed fitting shall be pressed. If no un-pressed fitting is identified the system shall be pressurized to test pressures required by code, not to exceed 600 psi.

G. HANGERS AND SUPPORTS

1. Comply with requirements in Division 23 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 1)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4
10	18	22	3/4	7/8
12	19	23	3/4	7/8
14	22	25	7/8	1
16	23	27	7/8	1
18	25	28	1	1
20	27	30	1	1-1/4
24	28	32	1-1/4	1-1/4

Note 1: Refer to manufacturer’s recommendations for grooved end piping systems.

END OF SECTION

SECTION 232114

HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Expansion tanks.

B. Air vents.

C. Air separators.

D. Suction diffusers.

E. Pump connectors.

F. Combination pump discharge valves.

G. Pressure-temperature test plugs.

H. Balancing valves.

I. Combination flow controls.

J. Flow meters.

K. Relief valves.

L. Pressure reducing valves.

M. Thermometers

N. Pressure Gauges

O. Glycol system.

1.2 RELATED REQUIREMENTS

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

B. Section 22 - Plumbing Piping Specialties: Backflow preventers.

C. Section 23 - Hydronic Piping.

D. Section 23 - HVAC Water Treatment: Pipe cleaning.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

B. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.

C. ASME B16.11 - Forged Fittings, Socket-welding and Threaded.

D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of work of this section with size, location and installation of service utilities.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.

B. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Maintenance Contract.

E. Project Record Documents: Record actual locations of flow controls.

F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Extra Glycol Solution: One container, 1 gallon size.
2. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flow meter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 EXPANSION TANKS

A. Manufacturers:
1. Armstrong Fluid Technology
2. Amtrol Inc
3. ITT Bell & Gossett
4. Taco, Inc;

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.

C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psi .

D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

E. Hot Water: HWET-1 and HWET-2: Hot water system shall be served by two (2) Model 3000L tank with an acceptance volume of 792 gallons water each.

F. Chilled Water: CHWET-1: Chilled water system shall be served by one (1) Model 800L tank with an acceptance volume of 211 gallons water.

2.2 AIR VENTS

A. Manufacturers:
1. Armstrong International, Inc.
2. ITT Bell & Gossett
3. Taco, Inc.

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

C. Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

D. Washer Type:
1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.3 AIR SEPARATORS

A. Manufacturers:
1. B+G Model Rolairtrol
2. Taco.
3. Spirotherm.
4. Armstrong.

B. Cast iron for sizes 2-1/2 inch and smaller, steel for sizes 3 inch and larger; perforated stainless steel air collection tube, tested and stamped in accordance with AS ME SEC 8-D for 125 psig operating pressure. Pressure drop shall be less the 1.0 psig and air removal shall be minimum 91% for flows shown on the drawings. Equipment size shall match the pipe size as shown on the drawings.

2.4 STRAINERS

A. Manufacturers:
1. Armstrong International, Inc.
2. Watts
3. Grinnell Products

B. Size 2 inch and Under:
1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:
1. Provide flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
1. Provide flanged iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.5 SUCTION DIFFUSERS

A. Manufacturers:
1. Armstrong Fluid Technology
2. ITT Bell & Gossett
3. Taco, Inc
4. Victaulic

B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh start up screen, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.6 PUMP CONNECTORS

A. Manufacturers:

1. The Metraflex Company Flexicraft Mason Industries

B. Stainless-Steel Bellow, Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, bronze or stainless steel, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

C. Spherical, Rubber, Flexible Connectors:
1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.7 COMBINATION PUMP DISCHARGE VALVES (for constant volume pumps only)

A. Manufacturers:
1. Armstrong Fluid Technology
2. ITT Bell & Gossett
3. Taco, Inc
4. Victaulic

B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.8 PRESSURE-TEMPERATURE TEST PLUGS

A. Manufacturers:
1. Ferguson Enterprises Inc
2. Peterson Equipment Company Inc
3. Sisco Manufacturing Company Inc
4. Substitutions: See Section 01 - Product Requirements.

B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F .

C. Application: Use extended length plugs to clear insulated piping.

2.9 BALANCING VALVES - MANUAL

A. Manufacturers:
1. Armstrong Fluid Technology
2. ITT Bell & Gossett
3. Taco, Inc
4. Nexus
5. Grisworld
6. Tour & Anderson

B. Brass or Bronze, Calibrated-Orifice, Balancing Valves:
1. Construction: Bronze or brass alloy housing, ball or plug type with calibrated orifice or venturi. The valve shall come fully assembled and be permanently marked to show direction of flow.
2. CWP rating: 400PSI/250°F.
3. Pressure gauge connections: dual pressure/temperature test valves for flow reading, and a union end which will accept various end pieces.
4. The body design shall allow inspection or repair of handle operated stem without disturbing piping connections. The repairable stem shall include two Teflon seals and one EPDM O-ring for protection against chemicals and modulating temperature.

C. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Stem Seals: EPDM O-rings.
4. Disc: Manufacturer standard construction.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
7. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig 860 kPa.
10. Maximum Operating Temperature: 250 deg F 121 deg C.

2.10 BALANCING VALVES AUTOMATIC

A. Manufacturers:
1. Nexus UltraMatic UM Series
2. Grisworld Isolator R Series
3. Flow Design AC Series
4. Victaulic 76B Series

B. Description:
1. Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with combination blow-down and back-flush drain.
2. Calibration: Control within 10 percent of design flow over entire operating pressure with a maximum operating temperature of at least 232 deg F.
3. Control Mechanism: Either piston and spring or diaphragm and orifice plates are acceptable types. For piston and spring types: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring. For diaphragm and orifice plate types: elastomeric polymer diaphragm with polyphenylsulfone orifice seat.
4. Accessories: In-line strainer on inlet and ball valve on outlet.
5. Manufacturer shall be able to provide certified independent laboratory tests verifying accuracy of performance. (Consult the factory for details).
6. All flow control valve cartridges shall be warranted by the manufacturer for five years from date of sale.
7. The body design shall allow inspection or removal of 20 mesh stainless steel strainer without disturbing piping connections.
8. Ball Valve shall be made of brass. Maximum pressure rating of 400 PSI. Ball Valve shall include a union end which will accept various end pieces.

9. The body design shall allow inspection or repair of handle operated stem without disturbing piping connections. The repairable stem shall include two Teflon seals and one EPDM O-ring for protection against chemicals and modulating temperature.
10. A pressure/temperature test valve, manual air vent and drain valve shall be included.
11. Dual pressure or pressure/temperature test valves for verifying accuracy of flow performance shall be provided for all valve sizes.
12. Valve shall have a body tag to indicate model number and a hanging tag showing Cv and flow/delta P reading required for specific flow rate.

2.11 COMBINATION FLOW CONTROLS

A. Manufacturers:
1. Armstrong Fluid Technology
2. ITT Bell & Gossett
3. Taco, Inc
4. Nexus
5. Grisworld

B. Size 2 inch and Under:
1. 300 psi, threaded or soldered ends; non-ferrous Ametal® brass copper alloy body, EPDM o-ring seals. 4-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting. Victaulic / TA Hydronics Series 787, 78K STAD or 786 STAS.

C. Size 2-1/2 inch and Larger:
1. 250 psi Flanged or 350 psi Grooved ends, ASTM A536 ductile iron body, all other metal parts of Ametal® brass copper alloy, EPDM O-ring seals. 8, 12 or 16 turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting. Victaulic / TA Hydronics Series 789 STAG or 788 STAF
2. Coil hook-up assemblies may be used to reduce installation time and space requirements. Victaulic TA Series 799 or 79V Koil Kit coil pack assembly. Coil pack can include; Victaulic Series 78U union port fitting, Series 78Y strainer/ball valve or Series 78T union/ball valve combination, and two flexible hoses

2.12 FLOW METERS (stand-alone type) Refer to 230900 for BAS flow meters

A. Manufacturers:
1. Dwyer Instruments, Inc
2. EMCO Flow Systems
3. Davis Instruments

B. Orifice principle by-pass circuit with direct reading gauge, soldered or flanged piping connections for 125 psi working pressure, with shut off valves, and drain and vent connections.

C. Direct reading with insert pitot tube, threaded coupling, for 150 psi working pressure, maximum 240 degrees F, 5 percent accuracy.

D. Cast iron, wafer type, orifice insert flow meter for 250 psi working pressure, with read-out valves equipped with integral check valves with gasketed caps.

E. Calibrated, plug type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer.

F. Cast iron or bronze, globe style, balance valve with handwheel with vernier type ring setting and memory stop, drain connection, readout valves equipped with integral check valves and gasketed caps.

G. Portable meter consisting of case containing one, 3 percent accuracy pressure gauge with 0-60 feet pressure range for 500 psi maximum working pressure, color coded hoses for low and high pressure connections, and connectors suitable for connection to read-out valves.

H. Portable meter consisting of case containing two, 3 percent accuracy pressure gauges with 0-135 inches and 0-60 feet pressure ranges for 500 psi maximum working pressure, color coded hoses for low and high pressure connections, and connectors suitable for connection to read-out valves.

2.13 DIAPHRAGM-OPERATED SAFETY VALVES: ASME LABELED.

A. Manufacturers:
1. AMTROL, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump.
4. Conbraco Industries, Inc.
5. Spence Engineering Company, Inc.
6. Watts Regulator Co.

B. Construction:
1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Wetted, Internal Work Parts: Brass and rubber.
7. Inlet Strainer: 304 or 316 stainless steel, removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.

C. 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.

2.14 PRESSURE REDUCING VALVES

A. Manufacturers:
1. Armstrong International, Inc
2. ITT Bell & Gossett
3. Taco, Inc
4. Watts

B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 2113.

C. Construction
   1. Valve Body: Constructed of bronze, cast iron, brass, iron
   2. Disc: Glass and carbon-filled PTFE.
   3. Seat: Brass.
   4. Stem Seals: EPDM O-rings.
   5. Diaphragm: EPT.

D. Provide integral check valve and strainer.

E. Maximum Inlet Pressure: 100 psi (689 kPa).

F. Maximum Fluid Temperature: 180 degrees F (82 degrees C).

G. Operating Pressure Range: Between 10 psi (69 kPa) and 25 psi (172 kPa).

2.15 THERMOMETERS

A. Manufacturers:
   1. Trerice
   2. Winters
   3. Weiss

B. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
   1. Size: Minimum 7 inch scale.
   2. Window: Clear glass or Lexan.
   3. Stem: Aluminum or Brass, length to suit installation.
   4. Accuracy: ASTM E77 2 percent.
   5. Calibration: Degrees F, or both degrees F and degrees C.

2.16 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions, and with cap and chain].

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.17 PRESSURE GAUGES

A. Manufacturers:
   1. Trerice
   2. Winters
   3. Weiss

B. Gauge: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
   1. Case: Sealed types, Aluminum or Stainless steel.
   2. Movement: Mechanical, with link to pressure element and connection to pointer.
   3. Dial Size: Minimum 4-1/2 inch diameter.
   4. Mid-Scale Accuracy: Grade A, plus or minus one percent.
   5. Scale: Psi, or both psi and kPa.

2.18 GLYCOL SOLUTION

A. Manufacturers:
1. DowFrost - Model - HD.
2. Houghton Chemical – Model – Safe-T-Therm.
3. Interstate Chemicals – Model – InterCool P300.
4. Substitutions: See Section 01 - Product Requirements.

B. Inhibited propylene glycol and water solution mixed 30 percent glycol - 70 percent water, suitable for operating temperatures from -40 degrees F to 250 degrees F.

PART 3 EXECUTION

3.1 INSTALLATION – HYDRONIC PIPING SPECIALTIES

A. Install specialties in accordance with manufacturer's instructions.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes. Install thermowells with extension on insulated piping. Fill thermowells with heat-transfer medium.

C. Install gauges and thermometers in locations where they are easily read from normal operating level.

D. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

E. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

F. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

G. Install thermowells with socket extending one-third of pipe diameter or to center of pipe and in vertical position in piping tees.

H. Where large air quantities can accumulate, provide enlarged air collection standpipes.

I. Provide manual air vents at system high points and as indicated.

J. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

K. Provide air separator on suction side of system circulation pump and connect to expansion tank.

L. Provide valved drain and hose connection on strainer blow down connection.

M. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

N. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.

O. Support pump fittings with floor mounted pipe and flange supports.

P. Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.

Q. Provide radiator balancing valves on water outlet from terminal heating units such as radiation, unit heaters, and fan coil units.

R. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, expansion tanks, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

S. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

T. Pipe relief valve outlet to nearest floor drain.

U. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

V. Clean and flush glycol system before adding glycol solution. Refer to Section 23 25 00 - HVAC Water Treatment.

W. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at [height of the building] times .433psi/ft + 5 psi.

X. Perform tests determining strength of glycol and water solution and submit written test results.

3.2 INSTALLATION - THERMOMETERS AND GAUGES

A. Install one pressure gauge for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gauge.

B. Install pressure gauges with pulsation dampers. Provide needle valve or ball valve to isolate each gauge. Extend nipples to allow clearance from insulation.

C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.

D. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.

E. Coil and conceal excess capillary on remote element instruments.

F. Provide instruments with scale ranges selected according to service with largest appropriate scale.

G. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

H. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.3 THERMOMETER SCALE RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F

B. Scale Range for Geothermal-Water Piping: 0 to 100 deg F

C. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F

D. Scale Range for Air Ducts: 0 to 150 deg F

3.4 PRESSURE GAUGE SCALE RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 200 psi

B. Scale Range for Geothermal-Water Piping: 0 to 200 psi

C. Scale Range for Heating, Hot-Water Piping: 0 to 200

3.5 MAINTENANCE

A. Provide service and maintenance of glycol system for one year from date of Substantial Completion at no extra charge to Owner.

B. Perform monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Report findings in detail in writing, including analysis and amounts of glycol or water added.

C. Explain corrective actions to Owner's maintenance personnel in person.

END OF SECTION

SECTION 232123

HYDRONIC PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. System lubricated circulators.

B. In-line circulators.

C. Vertical in-line pumps.

D. Close-coupled pumps.

E. Base-mounted pumps.

1.2 RELATED REQUIREMENTS

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

B. Division 03 - Cast-in-Place Concrete related sections.

C. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

D. Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment.

E. Section 23 0716 - HVAC Equipment Insulation.

F. Section 23 0719 - HVAC Piping Insulation.

G. Section 23 2113 - Hydronic Piping.

H. Section 23 2114 - Hydronic Specialties.

I. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. NEMA MG 1 - Motors and Generators

B. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

C. NFPA 70 - National Electrical Code.

D. UL 778 - Standard for Motor-Operated Water Pumps.

E. NEMA 250- Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 SUBMITTALS

A. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service clearances and finishes.

B. Millwright's Certificate: Certify that base mounted pumps have been aligned.

C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

D. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 - General Requirements.
2. Extra Pump Seals: (1) for each type and size of pump.
3. Extra Cartridges for Side-Stream Filters: One set for each filter.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Armstrong Pumps Inc.

B. Bell & Gossett.

C. Grundfos.

D. Taco Inc.

2.2 HVAC PUMPS - GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Minimum Quality Standard: UL 778.

C. Base Mounted Pumps: Aligned by qualified millwright.

D. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

2.3 SYSTEM LUBRICATED CIRCULATORS

A. Type: Horizontal shaft, single stage, direct connected with multiple speed wet rotor motor for in-line mounting, for 140 psig maximum working pressure, 230°F maximum water temperature.

B. Casing: Cast iron with flanged pump connections.

C. Impeller, Shaft, Rotor: Stainless Steel.

D. Bearings: Metal Impregnated carbon (graphite) and ceramic.

E. Motor: Impedance protected, multiple speed, with external speed selector.

F. Performance & Electrical Characteristics: See Pump Schedule on drawings.

2.4 IN-LINE CIRCULATORS

A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psig maximum working pressure unless otherwise indicated on the pump schedule.

B. Casing: Cast iron, with flanged pump connections.

C. Impeller: Non-ferrous keyed to shaft.

D. Bearings: Oil-lubricated bronze sleeve.

E. Shaft: Alloy steel with bronze sleeve, integral thrust collar.

F. Seal: Mechanical seal, 225°F maximum continuous operating temperature unless otherwise indicated on the pump schedule.

G. Drive: Flexible coupling.

H. Performance & Electrical Characteristics: See Pump Schedule on drawings.

I. Electrical Characteristics:
1. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.5 VERTICAL IN-LINE PUMPS

A. Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 175 psi working pressure unless otherwise indicated on the pump schedule.

B. Casing: Cast iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.

C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.

D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.

E. Seal: Mechanical seal, 225°F maximum continuous operating temperature unless otherwise indicated on the pump schedule.

F. Performance & Electrical Characteristics: See Pump Schedule on drawings.

G. Electrical Characteristics:
1. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.6 BASE-MOUNTED PUMPS

A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi maximum working pressure unless otherwise indicated on the pump schedule.

B. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

C. Impeller: Bronze, fully enclosed, keyed to shaft.

D. Bearings: Oil lubricated roller or ball bearings.

E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

F. Seal: Mechanical seal, 225°F maximum continuous operating temperature unless otherwise indicated on the pump schedule.

G. Drive: Flexible coupling with coupling guard.

H. Baseplate: Cast iron or fabricated steel with integral drain rim.

I. Performance & Electrical Characteristics: See Pump Schedule on drawings.
1. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

C. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation. Pumps shall be non-overloading where indicated on the pump schedule.

D. ,[Provide separate inlet and outlet shut-off valves. See 23 2114 for valve kits for system lubricated circulators].

E. Full Line size is the piping size shown on the drawings for the inlet and outlet of each pump and is NOT the pump inlet and outlet connection size.

F. Provide full line size isolation valve, pressure gauge, strainer and flex connector on inlet of all pumps. Provide full line size flex connector, check valve, balance valve, pressure gauge and isolation valve on outlet of all pumps. These items are to be provided for all cases whether indicated on not. Provide pipe reducer on outlet to connect full line size to pump outlet size. Balance valve on VFD driven pumps are not required. Provide pump suction diffuser on all base mounted pumps. See valve section for specific valve requirements.

G. Provide air cock and drain connection on horizontal pump casings.

H. Provide drains for bases and seals, piped to and discharging into floor drains.

I. Check, align, and certify alignment of base-mounted pumps prior to start-up.

J. Install close-coupled and base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Division 03 concrete related sections.

K. Lubricate pumps before start-up.

END OF SECTION

SECTION 232213

STEAM AND CONDENSATE HEATING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Steam supply and steam condensate return piping.
2. Equipment drains and over flows.
3. Unions and flanges.

B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 09 90 00 - Painting and Coating: Product requirements Painting for placement by this section.
4. Section 23 05 00 – Common Work Results for HVAC: Product and execution requirements for expansion compensation devices use in steam piping systems.
5. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product and execution requirements for expansion compensation devices use in steam piping systems.
6. Section 23 05 23 - General-Duty Valves for HVAC Piping: Product requirements for valves for placement by this section.
7. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, [and firestopping] for placement by this section.
8. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
9. Section 23 22 16 - Steam and Condensate Piping Specialties: Product and execution requirements for piping specialties used in steam piping systems.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Gray Iron Threaded Fittings.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B31.1 - Power Piping.
6. ASME B31.9 - Building Services Piping.
7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High- Temperature Service.

3. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
4. ASTM B32 - Standard Specification for Solder Metal.
5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings and accessories. Provide manufacturers catalogue information.

C. Welders Certificate: Include welder’s certification of compliance with ASME SEC 9.

D. Test Reports: Indicate results of piping system pressure test.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves, equipment and accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.1 and ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 CARBON STEEL PIPING

A. Pipe: Welded or seamless carbon steel conforming to ASTM A53. Provide piping with threaded ends up to 2” and beveled ends in sizes over 2”. Steam supply piping, equipment drains, relief vents and vents serving condensate return units shall be Scheduled 40 and steam condensate/return (gravity and pumped) shall be Schedule 80.

B. Fittings:
1. Sizes 2” and Under: Malleable iron, screwed, 150 lb. Conforming to ASME B16.3 as manufactured by Anvil International, Ward Manufacturing or approved equal.
2. Sizes Over 2”: Standard weight butt weld carbon steel conforming to ASTM A234 as manufactured by Anvil International, Ward Manufacturing or approved equal. Elbows shall be long radius type. Tees and fittings shall be prefabricated except Weldolet type fittings may be used where branch line is less than ½ the size of the main. Reducers shall be eccentric.

C. Flanges: Class 150 socket or welding neck type with raised face and spiral serrated finish conforming to ASTM A105 as manufactured by Anvil International, Ward Manufacturing or approved equal. Gaskets shall be Teflon molded on perforated steel disc. Bolts shall be unfinished square head machine bolts conforming to ASTM A307.

D. Joints: Threaded with Teflon pipe thread tape, welded per AWS D1.1 or flanged.

2.2 UNIONS AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Under: 150 psig malleable iron, threaded.

B. Dielectric Connections: Union or flange with water impervious isolation barrier; Watts 3000 Series or approved equal.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient. Install piping to conserve building space and not interfere with use of space. Group piping at common elevations whenever practical. Sleeve pipe passing through partitions, walls, and floors.

C. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to section 230700.

E. Slope piping and arrange systems to drain at low points. Pitch steam and pumped condensate piping at 1 inch per 40 feet and gravity condensate at 1 inch per 20 feet in direction of flow. Use eccentric reducers to maintain top of pipe level. Provide ¾" drain valves with hose end connections at all low points, bases of vertical risers, main shut-off valves and at equipment.

F. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

G. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided. Use non-conducting dielectric connections whenever joining dissimilar metals in open systems.

H. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

3.3 CLEANING AND FLUSHING

A. Upon completion of all work, all piping systems shall be flushed with water to remove dirt, grease, grit, chips and foreign matter.

B. Solution for flushing shall be used in sufficient quantity to produce a velocity of at least 2.5 feet per sound. Flushing shall continue until discharge solution shows no discoloration or evidence of foreign materials.

C. During flushing operation, all valves shall be operated several times, bypasses opened and equipment flushed.

D. Upon completion of flushing operations, all strainers and blow-downs shall be removed and cleaned of accumulated waste.

3.4 TESTING

A. All piping systems installed under this Contract shall be pressure tested with clean, clear water to insure tightness. Low pressure steam and medium pressure steam supply shall be pressure tested at 150 psig. Steam condensate/return piping and pumped condensate piping shall be pressure tested 100 psig.

B. Contractor shall be responsible for furnishing all plugs, piping, valves, hoses, and pumps necessary for required tests and for proper disposal of the water upon completion of the tests. All lines shall be thoroughly cleaned before testing.

C. Items which are not to be subjected to the hydrostatic test shall be either removed or blanked off. Short sections of piping which must be removed to permit the installation of blinds or blanks must be tested separately.

D. The test pump hook-up for hydrostatic test shall be such that the pressure may be applied gradually under perfect control. A valve shall be provided for blocking in the piping during the test period. The system should be filled with water thru a low connection point, care being taken that air is completely vented so that there are no air pockets remain. The pressure shall be applied gradually and held at the specified value for the time required to visually check each weld, connection, joint, flange, etc., but not less than a minimum of two hours. Test readings may be taken at the lowest point of the line or system of lines providing static head is added to the minimum hydrostatic test pressure. Care shall be taken to insure that at no point a dangerous over-pressure is experienced.

E. The hydrostatic test shall be considered satisfactory if no visible leakage, cracks or other signs of distress are discovered on the piping or at any joints. There is no requirement for minimum pressure drop during the test period; however, the cause of any pressure loss other than that due to temperature change or similar reasons shall be justified to the satisfaction of the Owner’s representative.

F. Minor leaks in screwed or flanged joints may be repaired without retesting subject to the approval of the Owner.

G. After completion of the hydrostatic testing, the system shall be completely drained at all low points. All test blinds, temporary supports, test equipment, etc. shall then be removed, and any valves, orifice plates, short sections of piping, miscellaneous in-line equipment or instruments that were removed prior to testing shall be re-installed the line left ready for service.

H. If there is any danger of contamination or freezing, blow out the piping system with dry, oil-free air as necessary.

I. At completion of test contractor shall submit a typewritten log of test data for Owner's permanent file including:
1. Data of test.
2. Section tested-attach sketch.
3. Equipment used.
4. Personnel involved.
5. Owner or Owner's witness in attendance.
6. Results.

After repair any failed test shall be repeated until all requirements of this Section are met.

END OF SECTION

SECTION 232216

STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Gate valves.
2. Globe valves
3. Pressure gages.
4. Pressure gage taps.
5. Steam traps.
6. Strainers.
7. Flash tanks.
8. Pressure-reducing valves.
9. Steam safety/relief valves.
10. Steam condensate meters.
11. Condensate return units.
12. Specialty components.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 22 13 - Steam and Condensate Heating Piping: Execution requirements for piping connections to products specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. ASTM International:
1. ASTM A105/A105M - Standard Specification for Carbon Steel Forgings for Piping Applications.
2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
4. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

C. Underwriters Laboratories Inc.:
1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.3 PERFORMANCE REQUIREMENTS

A. Steam Traps:
1. Select to handle minimum of two times maximum condensate load of apparatus served.
2. Pressure Differentials:

a. Low Pressure Systems (5 psi and less): 1/4 psi.
b. Low Pressure Systems (15 psi maximum): 2 psi.
c. Medium Pressure Steam (60 psi maximum): 15 psi.
d. High Pressure Steam (100 psi maximum): 30 psi.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit for manufactured products and assemblies used in this Project.
1. Manufacturer’s data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
4. Submit electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of actual locations of components and instrumentation

C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience].

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.10 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

1.11 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two service kits for each size and type of steam trap.

PART 2 PRODUCTS

2.1 GATE VALVES

A. Manufacturers:
1. Crane Valve, North America.
2. Milwaukee Valve Company.
3. NIBCO, Inc.
4. Stockham Valves.

B. 2 inches and Smaller: Bronze body, bronze trim, threaded union bonnet, non-rising stem, hand-wheel, solid wedge disc, threaded ends.

C. 2-1/2 inches and Larger: Iron body, bronze trim, bolted bonnet, non-rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Valves located in Mechanical Rooms which are installed above 8’0” above finished floor shall be provided with chain operator with chain guides and chain of sufficient length to operate at 36” above finished floor.

D. Pressure Class:
1. All valves unless noted otherwise: Class 125.
2. High pressure steam: Class 200 or 300.

2.2 GLOBE VALVES

A. Manufacturers:
1. Crane Valve, North America
2. Milwaukee Valve Company
3. NIBCO, Inc.
4. Stockham Valves & Fittings
5. Watts

B. 2 inches and Smaller: Bronze body, bronze trim, threaded bonnet, hand wheel renewable composition disc and bronze seat, threaded ends.

C. 2-1/2 inches and Larger: Cast iron body, bronze trim, hand wheel, rotating plug-type disc with renewable seat ring and disc, outside screw and yoke, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor. Valves located in Mechanical Rooms which are installed above 8'0" above finished floor shall be provided with chain operator with chain guides and chain of sufficient length to operate at 36" above finished floor.

D. Pressure Class:
1. All valves unless noted otherwise: Class 125.
2. High pressure steam: Class 200 or 300.

2.3 SWING CHECK VALVES

A. Horizontal Swing Check Valves:
1. Manufacturers:
a. Crane Valve, North America
b. Milwaukee Valve Company
c. NIBCO, Inc.
d. Stockham Valves & Fittings
e. Watts
2. 2 inches and Smaller: MSS SP 80, bronze body and cap, bronze seat, TFE seat N disc, threaded ends.
3. 2-1/2 inches and Larger: MSS SP 71, Iron body, bolted cap, cast bronze disc, renewable disc seal and seat, flanged ends.

B. Pressure Class:
1. All valves unless noted otherwise: Class 125.
2. High pressure steam: Class 200 or 300.

2.4 INVERTED BUCKET TRAPS

A. Manufacturers:
1. Sarco Type B.
2. Other acceptable manufacturers offering equivalent products.
a. Armstrong.
b. Yarway.
c. Tunstall.

B. Construction: Cast iron body with bolted cover, bucket, stainless steel seats and plungers, and stainless steel lever mechanism with knife edge operating surfaces.

C. Rating: 120 psig WSP.

D. Features: Access to internal parts without disturbing piping, top test plug, bottom drain plugs, bimetal air vent.

2.5 FLOAT AND THERMOSTATIC TRAPS

A. Manufacturers:
1. Sarco Type FT-30.
2. Other acceptable manufacturers offering equivalent products.
a. Armstrong.
b. Yarway.
c. Tunstall.

B. Construction: ASTM A126, cast iron body and bolted cover, stainless steel air vent, stainless steel float, stainless steel or copper float, stainless steel lever and valve assembly

C. Rating: 30 psig WSP.

D. Features: Access to internal parts without disturbing piping, bottom drain plug.

2.6 THERMODYNAMIC STEAM TRAPS

A. Manufacturers:
1. Sarco Model TD-52.
2. Other acceptable manufacturers offering equivalent product include:
a. Armstrong.
b. Yarway.
c. Tunstall.

B. Construction: Thermodynamic type with Insulcap insulated cap.

C. Rating: 600 psig WSP.

2.7 STRAINERS

A. Manufacturers:
1. Sarco Models listed below.
2. Other acceptable manufacturers offering equivalent product include:
a. Armstrong.
b. Yarway.

B. Size 2 inch and Under: Screwed cast iron body for 250 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen. Sarco Model IT.

C. Size 2-1/2 inch and Larger: Flanged iron body for 100 psig working pressure, basket pattern with 3/64 inch for 3” to 6” and 1/16 inch for 8” to 16” stainless steel perforated screen. Sarco Model F-125.

2.8 CONDENSATE RETURN UNITS

A. Manufacturers:
1. Bell & Gossett.
2. Other acceptable maufacturers offering equivalent products:
a. Sarco.

b. Skidmore

B. Components: Factory assembled, duplex unit with cast iron receiver, two close coupled pumps with brass inlet shutoff valves, two float switches, automatic electric alternator, control panel, inlet strainer and water level gauge.

C. Control panel shall be factory mounted and wired and shall include disconnect switches interlocked with door, circuit breakers, magnetic starters, pilot lights, and 120 volt controls.

2.9 FLASH TANKS

A. Flash tank shall be Sarco Size 6 or approved equal.

B. Construction: Fabricated steel for 150 psig working pressure and 500 degree F working temperature constructed in accordance with ASME Code and ASME stamped for 150 psig steam service. Unit shall be vertical configuration with support legs. Provide with 150 pound flanged inlet and outlet and threaded vent and tank drain connection.

C. Unit Capacity: 500 pounds per hour of flash steam.

2.10 PRESSURE REDUCING VALVES

A. Manufacturers:
1. Spence Type ED.
2. Other acceptable manufacturers offering equivalent products include:
a. Leslie.
b. Sarco.

B. Construction: Cast iron body, stainless or chrome steel valve spring, stem, and trim, stainless steel diaphragm, pilot operated, ANSI 250 lb. flanged connections.

C. Capacity: [ ] lbs. per hour with [ ] psig inlet pressure and [ ] psig outlet pressure. Valve

2.11 SAFETY RELIEF VALVES

A. Manufacturers:
1. Spence Figure 41.
2. Other acceptable manufacturers offering equivalent products include:
a. Leslie.
b. Sarco.

B. Valve: Bronze body, plated steel valve spring, stem, and trim, direct pressure actuated, capacities ASME certified and labeled for 250 psig steam pressure.

2.12 PRESSURE GAUGES

A. Manufacturers:
1. Trerice No. 600 Series.
2. Other Acceptable manufacturers offering equivalent products include:
a. Ernst Gage Co.
b. Davis Instrument Mfg. Co.

B. Construction: 3-1/2" round flangeless aluminum case, bottom outlet, clear glass window, accuracy within 1% over middle half and 1-1/2% over the balance.

C. Accessories: Gauge cocks, brass coil syphon.

2.13 [SELF CONTAINED] STEAM CONTROL VALVE

A. Manufacturers:
1. Spence Model T3.
2. Other acceptable manufacturers offering equivalent products:
a. Powers.
b. Sarco.

B. Construction:
1. Control valve shall be self contained capillary tube type.
2. Valve body shall be globe valve type and shall be constructed of bronze body with stainless steel trim and union connections.
3. Actuator shall be constructed of two-ply bronze bellows, steel actuator spring and steel overload spring
4. Bulb, bulb well and flexible armor covered capillary shall be [stainless steel]. Bulb shall be provided with union connection. [Provide with unit mounted dial temperature gauge.]

C. Control valve shall be [2"] with capacity of [1500] lbs per of steam entering at [20] psig. Sensing bulb shall have [40] degrees F to [100] degrees F range. Temperature setpoint shall be adjustable.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access to devices where not exposed.

C. Steam Traps:
1. Provide minimum ¾ inch size on steam mains and branches.
2. Install with union or flanged connections at both ends.
3. Provide gate valve and strainer at inlet, and gate valve and check valve at discharge. Provide check valve at discharge where condensate is "lifted".
4. Provide minimum 10 inch long, line size dirt leg between equipment return connection and trap.

D. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

E. For steam traps in high pressure and medium pressure mains, provide ¾ inch nipple in bottom of main, extending ¾ inch into and above bottom of pipe.

3.2 INSTALLATION – RELIEF VALVES

A. Terminate relief valves to outdoors 3 feet minimum above roof unless noted otherwise. Provide drip pan elbow with drain connection to nearest floor drain.

B. Rate relief valves for pressure upstream of pressure reducing station, for full operating capacity. Set relief at maximum 20 percent above reduced pressure.

C. When several relief valve vents are connected to a common header, header cross section area shall equal sum of individual vent outlet areas.

3.3 INSTALLATION - GAGES

A. Do not install steam pressure gauges until after systems are pressure tested.

B. Install pressure gages with pulsation dampers. Provide needle valve to isolate each gage. Install siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.

C. Provide instruments with scale ranges selected according to service with largest appropriate scale.

D. Install gages in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

E. Adjust gages to final angle, clean windows and lenses, and calibrate to zero.

END OF SECTION

SECTION 232300

REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Check valves.

G. Pressure regulators.

H. Pressure relief valves.

I. Filter-driers.

J. Solenoid valves.

K. Expansion valves.

L. Receivers.

M. Flexible connections.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Division 07 - Thermal and Moisture Protection

C. Division 08 - Openings

D. Division 09 - Finishes

E. Division 23 - Mechanical

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers

B. AHRI 710 - Performance Rating of Liquid-Line Driers.

C. AHRI 730 (I-P) - Flow Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers

D. AHRI 750 - Thermostatic Refrigerant Expansion Valves

E. AHRI 760 - Performance Rating of Solenoid Valves for Use With Volatile Refrigerants

F. ASHRAE Std 15 - Safety Standard for Refrigeration Systems

G. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants

H. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels

I. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications

J. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings

K. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes

L. ASME B31.5 - Refrigeration Piping and Heat Transfer Components

M. ASME B31.9 - Building Services Piping

N. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

O. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

P. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

Q. ASTM B88 - Standard Specification for Seamless Copper Water Tube

R. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

S. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers

T. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.

U. AWS D1.1 - Structural Welding Code - Steel

V. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation

W. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

1.4 SYSTEM DESCRIPTION –

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

C. Liquid Indicators:
1. Use line size liquid indicators in main liquid line leaving condenser.
2. If receiver is provided, install in liquid line leaving receiver.
3. Use line size on leaving side of liquid solenoid valves.

D. Valves:
1. Use service valves on suction and discharge of compressors.
2. Use service valves on suction and discharge of evaporators.
3. Use gage taps at compressor inlet and outlet.
4. Use gage taps at hot gas bypass regulators, inlet and outlet.
5. Use check valves on compressor discharge.
6. Use check valves on condenser liquid lines on multiple condenser systems.

E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.

F. Strainers:
1. Use line size strainer upstream of each automatic valve.
2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
3. Use shut-off valve on each side of strainer.

G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.

H. Filter-Driers:
1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
2. [Use a filter-drier on suction line just ahead of compressor.]
3. [Use sealed filter-driers in lines smaller than 1/2 inch outside diameter.]
4. [Use sealed filter-driers in low temperature systems.]
5. [Use sealed filter-driers in systems utilizing hermetic compressors.]
6. [Use replaceable core filter-driers in lines of 1/2 inch outside diameter or greater.]

I. Solenoid Valves:
1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
2. Use in liquid line of single or multiple evaporator systems.
3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

J. Receivers:
1. Use on systems 10 tons and larger, sized to accommodate pump down charge.
2. Use on systems with long piping runs.

K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Product Data: Provide general assembly of specialties, including manufacturer's catalogue information. Provide manufacturers catalog data including load capacity.

C. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

D. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, equivalent piping lengths and sizes.

E. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

F. Test Reports: Indicate results of leak test, acid test.

G. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

H. Submit welders certification of compliance with ASME BPVC-IX.

I. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

J. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 - General Requirements
2. Extra Filter-Dryer Cartridges: One of each type and size.
3. Refrigeration Oil Test Kits: One, each containing everything required to conduct one test.
4. Extra Refrigerant: One container of refrigerant, five pound size.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall have the following responsibilities:
1. Note: Pipe sizes and routing on drawings are shown for reference only and based on listed manufacturer's equipment only.
2. Determine coordination and final routing, sizes and locations of all system piping and components.
3. Coordinate system requirements, valves, driers, and accessories for complete system with equipment manufacturer.
4. Calculate total system volume and refrigerant charge required for proper operation.
5. Provide installation instructions, drawings and field supervision to assure proper installation and performance.

1.7 QUALITY ASSURANCE

A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

C. Welders Certification: In accordance with ASME BPVC-IX.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.2 PIPING

A. Copper Tube: ASTM B280, Type ACR hard drawn or annealed.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.3 REFRIGERANT

A. Refrigerant: Based on equipment schedules

2.4 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:
   1. Henry Technologies
   2. Parker Hannifin/Refrigeration and Air Conditioning
   3. Sporlan, a Division of Parker Hannifin
   4. Substitutions: See Division 01 - General Requirements.

B. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.5 VALVES

A. Manufacturers:
1. Hansen Technologies Corporation
2. Henry Technologies
3. Flomatic Valves
4. Substitutions: See Division 01 - General Requirements.

B. Diaphragm Packless Valves:
1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F .

C. Packed Angle Valves:
1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F .

D. Ball Valves:
1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F

E. Service Valves:
1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.6 STRAINERS

A. Manufacturers:
1. Hansen Technologies Corporation
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Straight Line or Angle Line Type:
1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.7 CHECK VALVES

A. Manufacturers:
1. Hansen Technologies Corporation

2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Globe Type:
1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 425 psi.

C. Straight Through Type:
1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.8 PRESSURE REGULATORS

A. Manufacturers:
1. Hansen Technologies Corporation
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi range, for maximum working pressure of 450 psi.

2.9 PRESSURE RELIEF VALVES

A. Manufacturers:
1. Hansen Technologies Corporation
2. Henry Technologies
3. Sherwood Valve/Harsco Corporation
4. Substitutions: See Division 01 - General Requirements.

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi .

2.10 FILTER-DRIERS

A. Manufacturers:
1. Flow Controls Division of Emerson Electric
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Performance:
1. Flow Capacity - Liquid Line: Size per approved equipment capacity, rated in accordance with AHRI 710.
2. Flow Capacity - Suction Line: , Size per approved equipment capacity rated in accordance with AHRI 730 (I-P).
3. Water Capacity: Size per approved equipment capacity, rated in accordance with AHRI 710.

4. Water Capacity: As indicated in schedule, rated in accordance with AHRI 710.
5. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
6. Design Working Pressure: 350 psi, minimum.

C. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

D. Construction: UL listed.
1. Replaceable Core Type: Steel shell with removable cap.
2. Sealed Type: Copper shell.
3. Connections: As specified for applicable pipe type.

2.11 SOLENOID VALVES

A. Manufacturers:
1. Flow Controls Division of Emerson Electric
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.

C. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

2.12 EXPANSION VALVES

A. Manufacturers:
1. Flow Controls Division of Emerson Electric
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.

C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.13 ELECTRONIC EXPANSION VALVES

A. Manufacturers:
   1. Flomatic Valves
   2. Parker Hannifin/Refrigeration and Air Conditioning
   3. Sporlan, a Division of Parker Hannifin
   4. Substitutions: See Division 01 - General Requirements.

B. Valve:
   1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
   2. Capacity: compatible with compressor size it serves

C. Evaporation Control System:
   1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.

D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.14 RECEIVERS

A. Manufacturers:
   1. Henry Technologies
   2. Parker Hannifin/Refrigeration and Air Conditioning
   3. Sherwood Valve/Harsco Corporation.
   4. Substitutions: See Division 01 - General Requirements.

B. Internal Diameter 6 inch (150 mm) and Smaller:
   1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

C. Internal Diameter Over 6 inch :
   1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.15 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Circuit Hydraulics, Ltd
   2. Flexicraft Industries
   3. Penflex
   4. Substitutions: See Division 01 - General Requirements.

B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with piping parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Group piping whenever practical at common elevations and locations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Inserts:
1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

G. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08.

J. Flood piping system with nitrogen when brazing.

K. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

L. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Division 09- Finishes.

M. Insulate piping and equipment; refer to Section and Section 23 0700.

N. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

O. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

P. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

Q. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

R. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

S. Fully charge completed system with refrigerant after testing.

T. Provide electrical connection to solenoid valves. Refer to Division 26.

3.3 FIELD QUALITY CONTROL

A. See Division 01 - General Requirements

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test system with dry nitrogen to maximum allowable working pressure. Pressure shall hold for a minimum of 24 hours with no leakage allowed.

END OF SECTION

SECTION 232500

HVAC WATER TREATMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. System cleaner.
2. Closed system treatment (water).
3. Chemical feeder equipment including associated feeders, pumps, tanks, controls, meters and valves.
4. Test equipment.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 PERFORMANCE REQUIREMENTS

A. Provide Premixed Inhibited Propylene Glycol at the specified Percentage.

B. Closed hydronic systems, including hot-water heating, chilled water, shall have the following water qualities:
1. pH: Maintain a value within 9.0 to 10.5 [6.5 – 8.5 for Aluminum Heat Exchangers].
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand (systems without glycol): Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TDS: Maintain a maximum value of 10 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
   a. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
8. Microbiological Limits:
   a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
   b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
   c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
   d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
   e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

C. Product Data: Submit chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout products.

B. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

C. Operation and Maintenance Data: Submit data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.6 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience ,and with service facilities within 100miles of Project with water analysis laboratories and full time service personnel.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish fiveyear manufacturer warranty for pumps, valves and water meters.

1.10 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.

1.11 MAINTENANCE MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish chemicals for treatment and testing during warranty period.

PART 2 PRODUCTS

2.1 SYSTEM CLEANER

A. Manufacturers:
1. Biomin
2. Culligan
3. Aptech
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products [; sodium tri-Poly phosphate and sodium molybdate].

C. Biocide [; chlorine release agents including sodium hypochlorite or calcium hypochlorite, or microbiocides including quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones].

2.2 TREATMENT 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 in Part 1 "Performance Requirements" Article.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 2 gal..
2. Minimum Working Pressure: 125 psig.

2.4 TEST EQUIPMENT

A. Furnish white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titration burettes and associated reagents.

B. Furnish following test kits:
1. Alkalinity titration test kit.
2. Chloride titration test kit.
3. Sulphite titration test kit.
4. Total hardness titration test kit.
5. Low phosphate test kit.
6. Conductivity bridge, range 0 - 10,000 micro-ohms.

7. Creosol red pH slide, complete with reagent.
8. Portable electronic conductivity meter.
9. High nitrite test kit.

PART 3 EXECUTION

3.1 PREPARATION

A. Operate, fill, start and vent systems prior to cleaning. Use water meter to record capacity in each system. Place terminal control valves in open position during cleaning.

3.2 CLEANING

A. Concentration:
1. As recommended by manufacturer.
2. One pound per 100 gallons of water contained in the system.
3. One pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.
4. Fill steam boilers only with cleaner and water.

B. Hot Water Heating Systems:
1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
3. Circulate for 6 hours at design temperatures, then drain.
4. Refill with clean water and repeat until system cleaner is removed.

C. Chilled Water Systems:
1. Circulate for 48 hours, then drain systems as quickly as possible.
2. Refill with clean water, circulate for 24 hours, then drain.
3. Refill with clean water and repeat until system cleaner is removed.

D. Steam Systems:
1. Apply heat, slowly raising boiler temperature to 160 degrees F and maintain for 12 hours minimum.
2. Cool, then drain as quickly as possible.
3. Refill with clean water, drain, refill and check for sludge.
4. Repeat until system is free of sludge.
5. Apply heat to produce steam for piping system and maintain for 8 hours minimum. Bypass traps and waste condensate.

E. Use neutralizer agents on recommendation of system cleaner supplier and acceptance of Architect/Engineer.

F. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

G. Remove, clean, and replace strainer screens.

H. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and interconnecting piping. Install around balancing valve downstream of circulating pumps and as indicated on Drawings.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Install 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel. Furnish minimum two-hour training course for operating personnel, instruction to include installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.

END OF SECTION

SECTION 233100

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Duct Materials.

B. Non-Insulated Flexible ducts.

C. Insulated flexible ducts.

D. Single wall spiral round ducts.

E. Single wall spiral flat oval ducts.

F. Transverse duct connection system.

1.2 RELATED SECTIONS

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

1.3 REFERENCES

A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
4. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
5. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
6. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
7. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
8. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
9. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
10. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
11. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

12. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
3. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - Fibrous Glass Duct Construction Standards.
2. SMACNA - HVAC Air Duct Leakage Test Manual.
3. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

D. Underwriters Laboratories Inc.:
1. UL 181 - Factory-Made Air Ducts and Connectors.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" beef up duct hanger and support in this section.

C. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.5 SUBMITTALS

A. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire rated and other walls.
7. Terminal unit, coil, and humidifier installations.
8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

B. Product Data: Submit data for duct materials, duct liner, duct connectors .

C. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

B. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards as applicable.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 DUCT MATERIALS

A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 (zinc coating of in conformance with ASTM A90/A90M.

B. Steel Ducts: ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

C. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength. Mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

D. Stainless Steel Ducts: ASTM A480/A480M, Type 316. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article

E. Fasteners: Rivets, bolts, or sheet metal screws.

F. Hanger Rod: ASTM A36/A36M; steel , galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 NON-INSULATED FLEXIBLE DUCTS

A. Manufacturers:
1. Thermaflex Technaflex
2. Tuttle + Bailey
3. Flexmaster

B. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.
1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -20 degrees F to 210 degrees F.

2.3 INSULATED FLEXIBLE DUCTS

A. Manufacturers:
1. Thermaflex
2. Technaflex
3. Tuttle + Bailey
4. Flexmaster

B. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical wound spring steel wire; fiberglass insulation; polyethylene or aluminized vapor barrier film.
1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -20 degrees F to 210 degrees F.
4. Thermal Resistance: 6square feet-hour-degree F per BTU.
5. Vapor Barrier Permeance: 0.05 perm per ASRM E96, Procedure A

2.4 SEALANTS 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 according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
1. General: Brush-on, water-resistant, mold and mildew resistant, indoor and outdoor use, compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. VOC: Maximum 75 g/L (less water).
5. Maximum Static-Pressure Class: 10-inch wg, positive and negative.

C. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.

2. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.

2.5 SINGLE WALL SPIRAL ROUND DUCTS

A. Manufacturers include, but are not limited to:
1. McGill AirFlow Corporation
2. Semco Incorporated
3. Tangent Air Corp
4. Spiral Mfg. Co., Inc.

B. Product Description: UL 181, Class 1, round spiral lockseam duct constructed of galvanized steel.

C. Construct ducts and fittings gauge per the latest edition of SMACNA.

2.6 TRANSVERSE DUCT CONNECTION SYSTEM

A. Manufacturers:
1. United McGill
2. Semco
3. ACME
4. Nufab

B. Product Description: [SMACNA "E" rated] [SMACNA "F" rated] [or] [SMACNA "J" rated] rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.7 DUCTWORK FABRICATION

A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible . Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards). Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. TDC connections on all ductwork where any dimension exceeds 12 inches. Slip and drive connection acceptable on duct sizes less than 12” x 12”.

D. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide [airfoil] turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

G. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

H. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems.
   1. Sealants, Mastics: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
   2. Do not provide sealing products not bearing UL approval markings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

A. General:
   1. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. 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.
   2. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
   3. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
   4. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8inch and smaller.
   5. Install duct hangers and supports in accordance with Section 23 05 29.
   6. Use double nuts and lock washers on threaded rod supports.
   7. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
   8. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
   9. Do not route ducts through transformer vaults or electrical equipment rooms and enclosures.
   10. 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.

11. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23, Air Duct Accessories for fire and smoke dampers.

B. Flexible ductwork
1. When located above ceilings, support flexible duct from above; flexible duct shall not touch the ceiling.
2. Minimize kinks and sags
3. Flexible duct shall be located only where concealed and accessible.
4. Non-insulated flexible ductwork: Provide when the metal ductwork connected to is not insulated.
5. Insulated flexible ductwork: Provide when the metal ductwork connected to is insulated. R-value of flexible ductwork insulation shall meet or exceed the R-value of the metal ductwork insulation.
6. Elbow supports: Provide above flexible ductwork connections to ceiling diffusers. Use cable ties as indicated in the manufacturer's installation instructions.
7. Connections to rigid ductwork: Provide both a drawband and two layers of duct tape lapped approximately 25% at each connection of flexible ductwork to rigid ductwork. Drawbands shall be the non-metallic type listed and labeled in accordance with UL 181B. Duct tape shall be listed and labeled in accordance with UL 181B.

C. For outdoor ductwork, protect ductwork, ductwork supports, linings and coverings from weather.

3.3 DUCT SEALING

A. Duct Seal Level Description

Seal Level	Sealing Requirements*
A	All transverse joints, longitudinal seams, and duct wall penetrations. Pressure sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL0181B by an independent testing laboratory and the tape is used in accordance with that certification
B	All transverse joints, longitudinal seams. Pressure sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL0181B by an independent testing laboratory and the tape is used in accordance with that certification.
C	Transverse joints only.
Notes: Longitudinal seams are joints oriented in the direction of flow. Transverse joints are connections of two duct sections oriented perpendicular to airflow. Duct wall penetrations are openings made by any screw fastener, pipe, rod, or wire. Spiral lock seams in a round or flat oval duct need not be sealed. All other connections are considered transverse joints, including but not limited to spin-ins, taps, and other branch connections, access door frames and jambs, duct connections to equipment, etc.	

B. Minimum Duct Seal Levels

Duct Type

Duct Location	Supply		Exhaust	Return
	2-in. or less (1)	Greater than 2-in. (1)		
Outdoor	A	A	C	A
Unconditioned Space (2)	B	A	C	B
Conditioned Space	C	B	B	C
Notes: Duct design static pressure classification Includes indirectly conditioned spaces such as return air plenums				

3.4 INTERFACE WITH OTHER PRODUCTS

A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

B. Connect air terminal units to supply ducts directly or with five foot maximum length of flexible duct. Do not use flexible duct to change direction.

3.5 DUCTWORK LEAKAGE TESTING

A. The following ductwork systems shall be pressure/leakage tested:
   1. All ductwork to be concealed in a sheetrock, concrete block or other permanent chase shall be pressure tested before ductwork is concealed.
   2. IECC REQUIREMENTS
      a. Representative sections totaling no less than 25% of ductwork systems that are constructed and installed for 3” w.c. or more (positive or negative).
   3. For ductwork leakage testing: “Ductwork main” shall be defined as all ductwork serving more than one grille or diffuser.
   4. All ductwork outside of the building insulation envelope shall be pressure tested.

B. Testing shall conform to the following:
   1. Test static pressure must be the lower of 125% of the external static pressure of the air moving equipment or the construction static pressure class of the ductwork.
   2. Test in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Maximum Allowable Leakage shall be in accordance with Duct Pressure Class rating listed below and Leakage Class listed here-in.
   3. For Ductwork Pressure Class 3” w.c: Leakage Class shall be 8.
   4. For Ductwork Pressure Class 2” w.c or less: Leakage Class shall be 16.
   5. Testing shall occur after ductwork has been cleaned, but before duct insulation is applied or ductwork is concealed.

C. Duct Leakage Test Report shall include:
   1. Date of test.

2. Name of company and person conducting the test.
3. Name of company and person witnessing the test.
4. Description of ductwork tested. Provide drawings to indicate section of ductwork being tested. Labeling on the drawings shall correspond to labeling in the report.
5. Surface area (square feet) of section of ductwork being tested.
6. Duct design operating pressure (inches w.c.)
7. P = Duct design test static pressure (inches w.c.)
8. Duct capacity, air flow
9. CL= Specified Leakage Class.
10. F = Leakage factor (CFM / 100 sf of duct area)
11. Maximum allowable leakage (CFM)
12. Test apparatus
    a. Blower
    b. Orifice tube size
    c. Orifice size
    d. Calibrated
13. Test orifice differential pressure (inches w.c.)

3.6 SCHEDULES

A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply Air and Return Air unless noted otherwise	Galvanized Steel
Relief Air unless noted otherwise	Galvanized Steel
Outside Air unless noted otherwise	Galvanized Steel
Exhaust unless noted otherwise	Galvanized Steel
Supply Air at the discharge of humidifiers, for distance of 10’-0”	Stainless Steel
Sterilizer, Autoclave, Cart Washer Exhaust	Aluminum
All Ductwork at the Exterior of the Building	Stainless Steel
Combustion Air	Galvanized Steel

B. Ductwork Pressure Class Schedule:

AIR SYSTEM	PRESSURE CLASS
Supply Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Return Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Outside Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Exhaust Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Relief Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
AHU's Served by VAV boxes: All supply air ductwork from outlet of each AHU to inlet of each VAV box.	3 inch w.c. regardless of velocity.
Variable Air Volume Supply (downstream of VAV boxes)	1 inch w.c. regardless of velocity.
Variable Air Volume Supply (upstream of VAV boxes)	3 inch w.c.
Sterilizer, Autoclave, Cart Washer Exhaust	2 inch w.c.

END OF SECTION

SECTION 233300

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Back-draft dampers.

B. Combination fire-and-smoke dampers.

C. Duct access doors.

D. Dynamic fire dampers.

E. Ceiling fire dampers.

F. Smoke dampers.

G. Volume control dampers.

H. Flexible duct connections.

I. Duct test holes.

1.2 RELATED SECTIONS:

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

B. Section 23 05 19 – Meters and Gauges

C. Section 23 04 00 – General Conditions for Mechanical Trades

D. Section 23 09 23 - Direct-Digital Control System for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.

E. Section 23 31 00 - HVAC Ducts: Requirements for duct construction and pressure classifications.

F. Specification Section 28 31 00 – Fire Detection and Alarm: Installation of duct mounted smoke detectors.0

G. Section 26 05 03 - Electrical: Installation of duct mounted smoke detectors and Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.3 REFERENCES (follow the most currently adopted amended version)

A. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 92A - Recommended Practice for Smoke-Control Systems.

D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:
1. UL 555 - Standard for Safety for Fire Dampers.
2. UL 555C - Standard for Safety for Ceiling Dampers.
3. UL 555S - Standard for Safety for Smoke Dampers.

1.4 SUBMITTALS

A. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.

B. Product Data: Submit data for shop fabricated assemblies and hardware used.

C. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
1. Fire dampers including locations and ratings.
2. Smoke dampers including locations and ratings.
3. Backdraft dampers.
4. Flexible duct connections.
5. Volume control dampers.
6. Duct access doors.
7. Duct test holes.

D. Product Data: For fire dampers, smoke dampers, combination fire and smoke dampers submit the following:
1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
2. Indicate materials, construction, dimensions, and installation details.
3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

E. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of access doors test holes and dampers.

B. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.6 QUALITY ASSURANCE

A. Dampers tested, rated and labeled in accordance with the latest UL requirements.

B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

C. Storage: Store materials in a dry area indoor, protected from damage.

D. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 COORDINATION

A. Coordinate Work where appropriate with building control Work.

1.12 WARRANTY

A. Furnish five-year manufacturer warranty for duct accessories.

1.13 EXTRA MATERIALS

A. Fusible Links: Furnish quantity equal to 10 percent of number installed.

PART 2 PRODUCTS

2.1 BACK-DRAFT DAMPERS

A. Manufacturers:
1. Ruskin CB series
2. Price BDD Series
3. Greenheck EM Series

B. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, extruded aluminum. Blades, maximum 6 inch width, center pivoted, with flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

2.2 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
1. Ruskin
2. Price
3. Greenheck
4. Pottorff
5. Nailor

B. Type: Dynamic, fabricate in accordance with NFPA 90A, UL 555, and UL 555S.

C. Fire Resistance: 1-1/2 hours through penetrations with fire resistance ratings of less than 3 hours and 3 hours through penetrations with fire resistance ratings of 3 hours or more.

D. Leakage Rating: Class II, maximum of 20 cfm at 4 inches wg differential pressure.

E. Damper Temperature Rating: 250 degrees F for all except smoke control systems. Smoke control systems must be 350 degrees F rated.

F. UL 555S Differential Pressure Rating: 6 in. wg.

G. UL 555S Velocity Rating: 2000 fpm

H. Frame: minimum16 gage, galvanized steel.

I. Blades:
1. Style: Airfoil-shaped, single piece, double skin.
2. Action: Opposed or parallel.
3. Orientation: Horizontal.
4. Material: Minimum 16 gage equivalent thickness, galvanized steel.
5. Width: Maximum 6 inches.

J. Bearings: Stainless steel or Bronze Oilite pressed into frame.

K. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.

L. Linkage: Concealed in frame.

M. Release Device: Electric resettable link to allow damper to be automatically reset with an open & closed indicator.

N. Actuator: shall be qualified in accordance with UL 555S to the temperature rating of the damper. Provide with damper

O. Operators: UL listed and labeled spring return electric type suitable for 120 volt, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.

P. Fusible Link Release Temperature: 165 degrees F.

Q. Finish: Mill galvanized.

R. Factory installed sleeve provided with mounting angles. Furnish silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements. Provide out-of-partition type dampers with fire rated sleeve where conditions do not allow installation of damper within partition.

S. Smoke Detector: Duct mounted smoke detectors shall be furnished by Div. 28, installed by Div. 23. Power wiring by Div. 26, control wiring by Div. 28.

2.3 DUCT ACCESS DOORS

A. Manufacturers:
1. Ruskin
2. Elgen
3. Greenheck
4. Buckley
5. Kees
6. Pottorff
7.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
1. Less than 12 inches square, secure with sash locks.
2. Up to 18 inches Square: Furnish two hinges and two sash locks.
3. Up to 24 x 48 inches: Three hinges and two compression latches.
4. Larger Sizes: Furnish additional hinge.
5. Access panels with sheet metal screw fasteners are not acceptable.

D. Materials
1. Aluminum construction: Minimum 0.032” thick aluminum double wall door, minimum 0.032” thick aluminum frame. Provide for aluminum duct.
2. Steel construction: Minimum 24 gauge galvanized double wall door, minimum 24 gauge galvanized frame. Provide for galvanized steel duct.

3. Stainless steel construction: Minimum 24 gauge stainless steel double wall door, minimum 22 gauge stainless steel frame. Provide for stainless steel or aluminum duct.

E. Low Pressure Rectangular (Non-Grease-Ducts):
1. Door: For insulated ducts, provide double wall door with 1” or 2” insulation cavity – as necessary to accommodate required insulation. For non-insulated ducts, provide single wall door.
2. Gasket: Closed cell neoprene.
3. Hardware: Double (opposite side) cam latches or single cam latch with full length (piano style) hinge.
4. Insulation: Glass fiber type, 1” thick for ductwork with up to 1” thick acoustical lining or insulation wrap, 2” thick for ductwork with 1-1/2” and over acoustical lining or insulation wrap.

F. Low Pressure Round & Oval Duct (Non-Grease Ducts),
1. Insulated duct, low pressure (3” wg): Welded construction, 18 gauge galvanized steel, 24 gauge galvanized double wall door, double cam latches or single cam latch with full length (piano style) hinge, 2” thick glass fiber insulation.
2. Non-Insulated duct, low pressure (6” wg): 16 gauge galvanized door, plated steel full length (piano style) hinge, zinc plated draw latch(es) and keeper(s), closed cell neoprene gasket.

G. High pressure (10” wg): 18 gauge galvanized steel, 24 gauge galvanized double wall door, double cam latches or single cam latch with full length (piano style) hinge, 2” thick glass fiber insulation.
1. Hardware:
a. Cam latch type: Cam latches on (4) sides - (1) cam latch per side for 6”x6”, (2) cam latches per side for 8”x8” and over.
b. Hinge type: Cam latches on (3) sides, (1) cam latch per side for up to 16”x16”, (2) cam latches per side for 18”x18” and over.
2. Application: For ductwork rated over 3” pressure class positive or negative, provide high pressure access doors.

H. Grease Ducts: 16 gauge galvanized door, 16 gauge cold rolled steel (CRS) frame, 2,300°F ceramic fire gasket, UL 1978 Listed. Provide access doors where indicated on the drawings and where cleanouts are required by IMC Section 506.3.
1.

2.4 DYNAMIC FIRE DAMPERS

A. Manufacturers:
1. Ruskin
2. Price
3. Greenheck
4. Nailor
5. Pottorff

B. Fabricate in accordance with NFPA 90A and UL 555.

C. Fire Resistance: 1-1/2 hours through penetrations with fire resistance ratings of less than 3 hours and 3 hours through penetrations with fire resistance ratings of 3 hours or more.

D. Dynamic Closure Rating: Dampers classified for dynamic closure to 2000 fpm and 4 inches wg static pressure.

E. Construction:
1. Integral Sleeve Frame- Galvanized steel in gauges required by manufacturer's UL listing. Length: Minimum 20 gage formed Sleeve length shall extend approximately 3" on either side of the wall or floor to facilitate joining the collar to the duct.
2. Blades:
   a. Style: Curtain type, blades outside of airstream.
   b. Action: Spring or gravity closure upon fusible link release.
   c. Material: Minimum 24 gage roll formed, galvanized steel.
3. Closure Springs: Type 301 stainless steel, constant force type, if required.

F. Fusible Link Release Temperature: 165 degrees F.

G. Mounting: Vertical or horizontal as indicated on Drawings.

H. Finish: Mill galvanized.

2.5 CEILING FIRE DAMPERS

A. Manufacturers:
1. Ruskin CFD(R) series
2. Price
3. Greenheck
4. Nailor
5. Pottorff

B. Fire Rating: UL 555C classified and labeled as a 1-1/2 or 3 hour ceiling damper to match the roof/ceiling assembly.

C. Air Flow Rating: UL approved for dual directional air flow.

D. Frame: minimum 3 inches by minimum 20 gage galvanized steel with roll formed ridge for blade stop.

E. Blades:
1. Style: Two-piece, single-thickness with blade insulation, hinged in center, and held open with fusible link.
2. Action: Butterfly.
3. Orientation: Horizontal.
4. Material: Minimum 24 gage galvanized steel.

F. Hinge: Spring stainless steel, mechanically attached to blades.

G. Mounting: Horizontal.

H. Temperature Release Device: Fusible link, 165 degrees F.

I. Finish: Mill galvanized.

J. Performance Data:
   1. Pressure Drop: Maximum 0.1 inches w.g. at 500 fpm across 18 x 18 inch damper.

K. Fusible Volume Adjust damper: UL classified.

L. Extended Frame (if required):
   1. Rectangular Dampers: 6 inches thru11 inches.
   2. Round Dampers: 6-1/2 inches thru11-1/2 inches.

2.6 SMOKE DAMPERS

A. Manufacturers:
   1. Ruskin
   2. Air Balance
   3. Greenheck
   4. Nailor
   5. Pottorff

B. Fabricate in accordance with NFPA 90A and UL 555S.

C. Fire Resistance: 1-1/2 hours through penetrations with fire resistance ratings of less than 3 hours and 3 hours through penetrations with fire resistance ratings of 3 hours or more.

D. Leakage Rating: Class I, maximum of 8 cfm at 4 inches wg differential pressure..

E. Damper Temperature Rating: 250 degrees F.

F. Frame: 16 gage, galvanized steel.

G. Blades:
   1. Style: Airfoil-shaped, single piece, double skin.
   2. Action: Opposed.
   3. Orientation: Horizontal.
   4. Material: Minimum 13 gage equivalent thickness, galvanized steel.
   5. Width: Maximum 6 inches.

H. Bearings: Stainless steel pressed into frame.

I. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.

J. Linkage: Concealed in frame.

K. Operators: UL listed and labeled spring return electric type suitable for 120 volt, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.

L. Sleeve: Factory installed 16 gage sleeve, minimum 12 inches long.

M. Finish: Mill galvanized.

N. Smoke Detector: Duct mounted smoke detectors are furnished by Div. 28, installed by Div. 23. Power wiring by Div. 26, control wiring by Div. 28

2.7 VOLUME CONTROL DAMPERS

A. Manufacturers:
1. Ruskin
2. Nailor
3. Greenheck
4. Flexmaster
5. McGill Airflow
6. Nailor
7. Pottorff
8.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Splitter Dampers:
1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 3/8 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
4. Single Blade Dampers: Fabricate for duct sizes up to 12 x 48 inch.

D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.

E. End Bearings: Except in round ductwork 12inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg..

F. Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.8 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
1. Ventfabrics Inc. Ventglas
2. United McGill
3. Elgen
4. DuroDyne
5. Ventfabrics
6. Ductmate Industries

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Materials: Flame-retardant or noncombustible fabrics.

D. Coatings and Adhesives: Comply with UL 181, Class 1.

E. Metal-Edged Connectors: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of galvanized or aluminum sheet steel. Provide metal compatible with connected ducts.

F. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inchin the warp and 360 lbf/inchin the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

G. 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/inchin the warp and 440 lbf/inchin the filling.
3. Service Temperature: Minus 50 to plus 250 deg F

H. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd.
2. Tensile Strength: 285 lbf/inchin the warp and 185 lbf/inchin the filling.
3. Service Temperature: Minus 67 to plus 500 deg F

I. High-Corrosive-Environment System, Flexible Connectors:Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd.
2. Tensile Strength: 450 lbf/inchin the warp and 340 lbf/inchin the filling.
3. Service Temperature: Minus 67 to plus 500 deg F

J. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs. per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.9 DUCT TEST HOLES

A. Manufacturers:
1. Dwyer
2. Flow Kinetics
3. Air Balance
4. Substitutions: Division 01 - General Requirements.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

2.10 DUCT SILENCERS

A. Manufacturers:
1. IAC
2. Kinetics Noise Control
3. McGill AirSilence

4. Ruskin
5. Vibro-Acoustics.

B. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards. Silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.

C. Outer casing: ASTM A 653/A 653M minimum 22 gauge G90 galvanized sheet steel.

D. Casing seams and joints: Lock-formed and sealed or stitch welded and sealed.

E. Inner perforated metal liner: ASTM A 653/A 653M minimum 26 gauge G90 galvanized sheet steel.

F. Media: Acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be Type, Dimensions, and Performance: As indicated on the duct silencer schedule.

G. Rectangular elbow silencers: Acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters shall be provided as necessary to achieve the scheduled insertion loss. Silencers with a turning cross-section dimension greater than 48” shall have at minimum two half splitters and one full splitter.

H. Transitional silencers: Transitioning shall occur internal to the silencer such that the height of the gap or air passage is uniformly changing with the length of the splitters.

2.11 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. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass, Copper or Aluminum.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed.

F. Wall-Box Cover-Plate Material: Painted steel.

2.12 TURNING VANES

A. Manufacturers:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.

4. METALAIRE, Inc.
5. SEMCO Incorporated.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. 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.

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 for ducts up to 48 inches wide and double wall for larger dimensions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify rated walls are ready for fire damper installation.

B. Verify ducts and equipment installation are ready for accessories.

C. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.

B. Install duct mounted smoke detectors per NFPA 72. Refer to Specification Section 28 3100 for specification of smoke detectors.

C. Install motorized back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.

D. Access Doors: Install access doors of type suitable for application at the following locations:
1. Spaced every 50 feet of straight duct.
2. Upstream of each elbow.
3. Upstream of each reheat coil.
4. Upstream of each duct mounted smoke detector.
5. Before and after each duct mounted filter.
6. Before and after each duct mounted coil.
7. Before and after each duct mounted fan.
8. Before and after each automatic control damper.
9. Before and after each fire damper, smoke damper, combination fire and smoke damper.
10. Downstream of each VAV box.

11. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96.

E. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access. Install 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
   1. Mark access doors for fire and smoke dampers on outside surface, with minimum 1/2 inch high letters reading: FIRE/SMOKE DAMPER, SMOKE DAMPER, OR FIRE DAMPER.

F. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

G. Install fire dampers, combination fire and smoke dampers and smoke dampers at locations as indicated on Drawings and as indicated in specifications. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges. Install dampers and accessories with required clearance for access. Provide all power and control wiring for a complete and operable system.
   1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
   2. Install dampers square and free from racking with blades running horizontally.
   3. Do not compress or stretch damper frame into duct or opening.
   4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
   5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.3 DEMONSTRATION

A. Demonstrate re-setting of fire dampers to Owner's representative.

END OF SECTION

SECTION 233400

HVAC FANS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Fans.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
4. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
5. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
6. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
7. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:
1. AMCA 99 - Standards Handbook.
2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Refrigeration Institute:
1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.

D. ASTM International:
1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

E. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.

2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. Underwriters Laboratories Inc.:
1. UL 705 - Power Ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Wind-Borne Debris Loads: Design louvers located within 30 feet of grade to withstand ASTM E1996; large missile impact test.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork connections and accessory connections.

C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit fan manufacturer’s instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

D. Balance Quality: Conform to AMCA 204.

E. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish one year manufacturer’s warranty for fans.

1.12 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two sets of belts for each fan.

PART 2 PRODUCTS

2.1 FAN AND ROOF HOOD MANUFACTURERS

A. Manufacturers of HVAC fans and hoods shall be as specified in this list unless noted otherwise:
1. Greenheck
2. Loren Cook
3. Twin City
4. Acme

2.2 UP-BLAST CENTRIFUGAL ROOF FANS

A. Fan Unit: Up-blast lab type. V-belt drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

B. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

C. Motor: Totally enclosed fan cooled.

D. Roof Curb: Refer to Specification Section 23 0548.

E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.

F. Variable speed controller and ECM motor shall be provided for all direct drive fans not served by a variable frequency drive (VFD). Controller shall be factory mounted and wired and shall be used for balancing. Motor shall be an electronically commutated motor rated for continuous duty and provided with internally mounted potentiometer speed controller.

G. Motor Operated Damper: Refer to Specification Section 23 0923.

2.3 DOWNBLAST CENTRIFUGAL ROOF FANS

A. Fan Unit: Spun aluminum housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

B. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

C. Roof Curb: Refer to Specification Section 23 0548.

D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.

E. Variable speed controller and ECM motor shall be provided for all direct drive fans not served by a variable frequency drive (VFD). Controller shall be factory mounted and wired and shall be used for balancing. Motor shall be an electronically commutated motor rated for continuous duty and provided with internally mounted potentiometer speed controller.

F. Motor Operated Damper: Refer to Specification Section 23 0923.

2.4 CENTRIFUGAL SQUARE INLINE FANS

A. Product Description: Direct drive with galvanized steel housing, integral inlet cone, removable access doors on 3 sides, inlet and outlet duct collar, gravity backdraft damper in discharge, horizontal hanging brackets.

B. Fan Wheel: Backward inclined centrifugal type, aluminum construction.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Motor and Drive Mounting: Out of air stream.

E. Motor: Open drip proof.

F. Bearings: ABMA 9 life at 200,000 hours.

G. Variable speed controller and ECM motor shall be provided for all direct drive fans not served by a variable frequency drive (VFD). Controller shall be factory mounted and wired and shall be used for balancing. Motor shall be an electronically commutated motor rated for continuous duty and provided with internally mounted potentiometer speed controller.

H. Accessories:
1. Belt guard.
2. Motor cover.
3. Inlet safety screen where intake is not ducted.
4. Outlet safety screen.
5. Flexible duct connector.
6. Inlet and outlet ductwork companion flange.
7. Disconnect Switch: Factory mounted NEMA 250 Type 1 enclosure.
8. Motor Operated Damper: Refer to Specification Section 23 0923.

2.5 LAB EXHAUST FANS / HIGH PLUME DISCHARGE FANS

A. Fan Housing and Construction
1. Fan housing shall be a minimum 12 gauge steel construction.
2. Adjustable motor plate, where applicable shall utilize threaded studs for positive belt tensioning.
3. Fan shall be constructed with an integral housing drain to alleviate rainwater.
4. Fan shall contain a bolted and gasketed access door. Access door shall allow for the removal of wheel, shaft and bearings without the removal of the fan from the laboratory exhaust system.
5. Belt driven fan shafts shall be stainless steel and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum fan RPM.
6. Unit fasteners exposed to corrosive airstream shall be of stainless steel construction.
7. Unit components fabricated of steel shall be coated with an electrostatically applied, high performance, baked phenolic epoxy powder coating with an ultraviolet protective topcoat. Finish color shall be light gray. Coating thickness shall be 5.0 mils. Coating shall be salt spray tested per ASTM B117 for in excess of 1000 hours without failure, humidity resistance tested per ASTM D2247 for in excess of 1000 hours without failure, and impact resistance tested per ASTM D2794 and shall pass a minimum of 100 in-lbs.
8. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM.
9. Units specified as Spark Resistant Construction shall be constructed to the AMCA Spark Resistant Construction level as dictated on the plans and specifications.
10. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

B. High Plume Discharge Nozzle
1. Fans shall incorporate a conical discharge nozzle supplied by the fan manufacturer.
2. Discharge nozzle shall be constructed and designed to efficiently handle up to 6000 feet per minute outlet velocity. Nozzle shall not utilize a stack cap nor hinged cover and shall be matched to project specific requirements as noted on the contract drawings.

C. Centrifugal Fan Impeller
   1. Fan impeller shall be non-overloading, steel centrifugal, backward inclined, flatblade type. Blades shall be continuously welded to the backplate and deep spun inlet wheel shroud.
   2. Fan impeller hub shall be keyed and securely attached to the fan shaft.
   3. Fan impeller shall be statically and dynamically balanced in accordance with AMCA Standard 204-96, “Balance Quality and Vibration Levels for Fans.”
   4. Fan impeller shall be coated with a finish to match the fan housing.
   5. Fan impeller shall be balanced utilizing weights which are welded and coated with chemical resistant coating. Balancing by means of bolts and washers shall not be acceptable.
   6. Belt driven fan bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreaseable ball or roller type in a cast iron pillow block housing utilizing concentric mounting locking collars. Belt driven fan bearings shall be selected for a minimum L50 life of not less than 200,000 hours.
   7. Belt driven fan units shall have stainless steel lube lines installed from the fan bearings with Zerk fittings to allow for easy lubrication.

D. Bypass Air Plenum
   1. For constant volume or variable air volume provide bypass air plenum.
   2. Bypass air plenum shall be designed to support fan assembly (assemblies) and configuration(s) as shown on the contract drawings.
   3. Bypass air plenum shall introduce outside air above the roof level and shall have rain hood(s) and bird screen protection over the bypass air damper(s).
   4. Bypass air plenum shall be constructed of welded steel, minimum 14 gauge, with a finish to match the fan housing.
   5. Bypass dampers shall be opposed blade low leakage design. The dampers shall be aluminum construction and coated to match the fan housing.
   6. Provide with extended shafts and manual locking quadrant handles shall be provided for adjustment of the dampers. The extended shaft can be used for external connection to actuators by controls contractor.
   7. 24V electric actuators shall be provided to control the dampers. The actuators shall be provided by the fan manufacturer.
   8. Isolation dampers shall be gravity type coated to match fan housing.
   9. Isolation dampers shall be opposed blade low leakage design. The dampers shall be aluminum construction and coated to match the fan housing. 2-position, spring return actuators shall be provided. The actuator shall be pre-wired with appropriate transformer to the fan disconnect switch to open when the fan is energized and close via spring return when the fan is de-energized.

E. Fan Motors and Drives
   1. Fan motors shall be premium efficiency, NEMA frame, nominal 1800 or 3600 RPM Totally Enclosed Fan Cooled, Inverter Duty Labeled with a 1.15 service factor.
   2. Belt driven fan drive belts shall be oil and heat resistant, non-static type. Fixed drives shall be sized for a minimum 1.5 service factor (150% of the motor horsepower) and shall be readily and easily accessible for service, if required.
   3. Belt driven fans shall utilize precision machined cast iron type sheaves, keyed and securely attached to the wheel and motor shafts.

F. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.

2.6 CENTRIFUGAL UTILITY FAN

A. Description: Fan shall be a single width, single inlet, backward inclined flat blade, belt driven centrifugal vent set.

B. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL/cUL 705) for US and Canada. For restaurant applications, fan shall be listed by Underwriters Laboratories (UL/cUL 762) for US and Canada. For smoke control applications, fan shall be listed by Underwriters Laboratories (Power Ventilator for Smoke Control Systems) for US and Canada. Fan shall bear the AMCA Certified Ratings Seal for Sound and Air performance.

C. Construction: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper shall be a minimum 14 gauge steel and the scroll side panels shall be a minimum 12 gauge steel. The entire fan housing shall have continuously welded seams for leak-proof operation. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. The fan housing shall be field rotatable to any one of eight discharge positions and shall have a minimum 1-1/2 inch outlet discharge flange. Bearing support shall be minimum 10 gauge welded steel. Side access inspection ports shall be provided with quick release latches for access to the motor compartment without removing the weather cover. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

D. Coating: Steel fan components shall be LorenizedTM with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

E. Wheel shall be steel centrifugal backward inclined, non-overloading flat blade type. Blades shall be continuously welded to the back plate and deep spun inlet shroud. Wheel hub shall be keyed and securely attached to the fan shaft. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans

F. Motor shall be NEMA Design B with Class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.

G. Bearing: shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

H. Blower shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.

I. Belts shall be oil and heat resistant, static conducting. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM

J. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.

K. Variable speed controller and ECM motor shall be provided for all direct drive fans not served by a variable frequency drive (VFD). Controller shall be factory mounted and wired and shall be used for balancing. Motor shall be an electronically commutated motor rated for continuous duty and provided with internally mounted potentiometer speed controller.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 INSTALLATION

A. Secure roof fans and hoods with cadmium plated steel lag screws to roof curb. Secure roof fans with cadmium plated steel lag screws to roof curb. For other requirements, refer to Specification 230548.

B. Suspended Cabinet Fans: Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

C. Field installed motorized dampers at all fans, refer to Specification Section 23 0548.

D. Provide sheaves required for final air balance.

3.3 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer’s field services.

B. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Vacuum clean coils and inside of fan cabinet.

3.5 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate fan operation and maintenance procedures.

3.6 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 233600

AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single-duct terminal units.
   1. Single-duct, variable-volume units.

1.2 RELATED REQUIREMENTS

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

B. Section 22 0513 - Common Motor Requirements for Plumbing Equipment.

C. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

D. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

E. Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment.

F. Section 23 0913 - Instrumentation and Control Devices for HVAC: Thermostats and actuators.

G. Section 23 0923 - Direct-Digital Control System for HVAC.

H. Section 23 0993 - Sequence of Operations for HVAC Controls.

I. Section 23 2113 - Hydronic Piping: Connections to heating coils.

J. Section 23 2114 - Hydronic Specialties: Connections to heating coils.

K. Section 23 3100 - HVAC Ducts and Casings.

L. Section 23 3300 - Air Duct Accessories.

M. Section 23 3700 - Air Outlets and Inlets.

N. Section 23 8200 - Convection Heating and Cooling Units: Air coils.

O. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils

B. AHRI 880 (I-P) - Performance Rating of Air Terminals.

C. AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

D. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

E. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality.

F. ASHRAE Std 130 - Methods of Testing Air Terminal Units.

G. ASTM A492 - Standard Specification for Stainless Steel Rope Wire.

H. ASTM A603 - Standard Specification for Zinc-Coated Steel Structural Wire Rope.

I. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

K. ASTM E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.

L. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction.

N. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

O. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; Sheet Metal and Air Conditioning Contractors' National Association.

P. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

Q. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

A. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

B. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
   1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg .

C. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.

D. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.

E. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.

G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

H. Maintenance Materials: Furnish for Owner's use in maintenance of project.

I. Extra Materials:

   1. Motors: One of each type and size.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 WARRANTY

A. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The following list of manufacturers applies to all air terminal units unless otherwise noted in sections below.
   1. Price Industries
   2. Titus
   3. Carnes
   4. Nailor Industries
   5. Trane
   6. Carrier

7. Enviro-Tec

2.2 SINGLE-DUCT, VARIABLE-VOLUME AND CONSTANT-VOLUME UNITS

A. General:
1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.

B. Unit Casing:
1. Minimum 22 gage, 0.0299 inch galvanized steel.
a. Assembled with longitudinal lock seam construction.
b. Casing leakage to meet ASHRAE Std 130.
2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
3. Unit Discharge: Rectangular, with slip-and-drive connections.
4. Sound Attenuators: Where shown on plan provide manufacturer's integral 36" sound attenuator.
5. Acceptable Liners:
a. 1/2 inch thick, foil faced hospital grade liner.
1) Secure with adhesive.
2) Coat edges exposed to airstream with NFPA 90A approved sealant.
3) Cover liner with non-porous foil.

C. Damper Assembly:
1. Heavy-gage, galvanized steel or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
3. Incorporate low leak damper blades for tight airflow shutoff.
a. Air Leakage Past Closed Damper: Maximum two percent of unit maximum airflow at 3 inch wg inlet static pressure, tested in accordance with ASHRAE Std 130.

D. Hot Water Heating Coil (where scheduled):
1. Coil Casing: Minimum 22 gage, 0.0299 inch galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.
a. Access Door: Gasketed and insulated located on bottom, on top, and downstream of coils.
b. Right or left coil inlets.
2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
3. Coil leak tested to minimum 350 psig.
a. Minimum Burst Pressure: 1800 psi.
4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.

E. Controls:
1. DDC (Direct-Digital Controls):
a. Include a factory-installed, unit-mounted, direct-digital controller that includes the following:
1) 24 VAC power terminal or RJ-12 Power connection.
2) T-Stat Port for thermostat connection.
3) Service Port for Price Linker diagnostic equipment.
4) Damper actuator.
5) Fan output connection.
6) LED indication for troubleshooting.
7) Three binary staged heating outputs.
8) Binary cooling output.
9) S.A.T. sensor input.
10) Contact closure input.
11) Four analog outputs.
12) BACNET expansion module.
13) VAV expansion module.
b. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
c. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum airflow.
1) Occupied and unoccupied operating mode.
2) Remote reset of temperature or CFM set points.
3) Proportional, plus integral control of room temperature.
4) Monitoring and adjusting with portable terminal.
5) Time-proportional reheat coil control.
d. Room Sensor:
1) Compatible with temperature controls specified.
2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.
2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
a. Plastic parts shall be fire-resistant, complying with UL 94.
b. Signal accuracy: within 5 percent throughout operating range with a 90 degree sheet metal elbow directly at the inlet of the assembly.
c. Control tubing shall be protected by grommets at the wall of the air flow sensor's housing.
d. Provide sensor with a pressure transducer to interface with a DDC system.
e. Provide velocity pressure sensor with a removable access section for maintenance.
f. Suitable for operation with duct pressures between 0.25 and 3.0 inch wg inlet static pressure.
g. Include factory-mounted and piped, 5-micron filter; and adjustable, velocity-resetting, high-limit control with amplifying relay.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that conditions are suitable for installation.

B. Verify that field measurements are as shown on the drawings.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. See drawings for the size(s) and duct location(s) of the air terminal units.

D. Provide ceiling access doors or locate units above easily removable ceiling components.

E. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 0548.
1. See Section 23 0548.

F. Embed anchors in concrete in accordance with ASTM E488.

G. Do not support from ductwork.

H. Connect to ductwork in accordance with Section 23 3100.

I. Provide minimum of 5 ft of 1 inch thick lined ductwork downstream of units.

J. Install heating coils in accordance with Section 23 8200.

K. Verify that electric power is available and of the correct characteristics.

3.3 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 50 percent full flow.

3.4 FIELD QUALITY CONTROL

A. Provide manufacturer's field representative to test, inspect, instruct, observe, and review field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
1. Leak Test:
   a. After installation, fill water coils and test for leaks.
   b. Repair leaks and retest until no leaks exist.
2. Operational Test:
   a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Test and adjust controls and safeties.

c. Replace damaged and malfunctioning controls and other equipment.
d. Remove and replace malfunctioning units and retest as specified above.

3.5 CLEANING

A. Vacuum clean coils and inside of units.

END OF SECTION

SECTION 233700

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

C. Door grilles.

D. Louvers.

E. Louvered penthouses.

F. Roof hoods.

G. Goosenecks.

H. Gravity ventilators.

1.2 RELATED REQUIREMENTS

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

B. Division 09: Painting

C. Section 23 04 00 – General Conditions for Mechanical Trades

D. Section 23 33 00 - Air Duct Accessories.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating

B. AMCA 511 - Certified Ratings Program for Air Control Devices.

C. AMCA 540 – Debris Impact Resistance

D. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers.

E. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets.

F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

H. SMACNA (ASMM) - Architectural Sheet Metal Manual.

I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.4 SUBMITTALS

A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

B. Project Record Documents: Record actual locations of all air outlets and inlets.

C. Project Record Documents: Once the final Testing, Adjusting & Balancing Report is approved, record all typed airflow values on the as-built drawings.

D. Test Reports: Rating of air outlet and inlet performance.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of air outlets and inlets.

1.6 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.

B. Test and rate louver performance in accordance with AMCA 500-L.

C. AMCA 540 – Debris Impact Resistance

D. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers; 2015.

E. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

F. Maintain two copies of each document on site.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.8 WARRANTY

A. Furnish five year manufacturer warranty for air outlets and inlets.

1.9 EXTRA MATERIALS

A. Furnish one of each type and size extra air outlets and inlets.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The following list of manufacturers applies to all air terminal units unless otherwise noted in sections below.
   1. Price Industries
   2. Titus
   3. Krueger
   4. Nailor Industries
   5. Anemostat

2.2 ROUND CEILING DIFFUSERS

A. Type: Round, adjustable pattern, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with directional baffles where indicated. Diffuser collar shall project not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.

B. Fabrication: Steel with baked enamel finish.

C. Color: As selected by Architect from manufacturer's standard range.

D. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.3 RECTANGULAR CEILING DIFFUSERS

A. Type: Provide square, stamped, multi-core, square, adjustable pattern, stamped, multi-core, square and rectangular, multi-louvered, square and rectangular, adjustable pattern, multi-louvered, and diffuser to discharge air in 360 degree, one way, two way, three way, four way, and pattern with directional baffles where indicated.

B. Connections: Round.

C. Frame: Provide surface mount, snap-in, inverted T-bar, spline type. In plaster ceilings, provide plaster frame and ceiling frame.

D. Fabrication: Steel with baked enamel finish.

E. Color: As selected by Architect from manufacturer's standard range.

F. Accessories: Refer to schedule.

2.4 PERFORATED FACE CEILING DIFFUSERS

A. Type: Perforated face with fully adjustable pattern and removable face.

B. Frame: Surface mount type. In plaster ceilings, provide plaster frame and ceiling frame.

C. Fabrication: Steel with steel frame and baked enamel finish.

D. Color: As selected by Architect from manufacturer's standard range.

E. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.5 CEILING SLOT DIFFUSERS

A. Type: Continuous wide slot, , with adjustable vanes for left, right, or vertical discharge, , refer to schedule

B. Fabrication: Aluminum extrusions with factory clear lacquer finish.

C. Color: To be selected by Architect from manufacturer's standard range.

D. Frame: Refer to schedule.

E. Plenum: Integral, galvanized steel, insulated.

2.6 CEILING SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.

B. Frame: Refer to schedule.

C. Construction: Made of aluminum extrusions with factory enamel finish.

D. Color: As selected by Architect from manufacturer's standard range.

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.7 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Frame: Refer to schedule.

B. Fabrication: Steel with 20 gage, 0.0359 inch minimum frames and 22 gage, 0.0299 inch minimum blades, steel and aluminum with 20 gage, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.

C. Color: To be selected by Architect from manufacturer's standard range.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.8 CEILING LINEAR EXHAUST AND RETURN GRILLES

A. Type: Refer to schedule.

B. Frame: Refer to schedule.

C. Fabrication: Steel with 20 gage, 0.0359 inch minimum frames and 22 gage, 0.0299 inch minimum blades, steel and aluminum with 20 gage, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.

D. Color: To be selected by Architect from manufacturer's standard range.

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.9 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

A. Type: Refer to schedule.

B. Fabrication: Refer to schedule.

C. Color: To be selected by Architect from manufacturer's standard range.

D. Frame: Refer to schedule.

E. Frame: Channel lay-in frame for suspended grid ceilings.

F. Accessories: Refer to schedule.

2.10 WALL SUPPLY REGISTERS/GRILLES

A. Type: Refer to schedule.

B. Frame: Refer to schedule.

C. Color: To be selected by Architect from manufacturer's standard range.

D. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.11 WALL SUPPLY REGISTERS/GRILLES

A. Type: Refer to schedule.

B. Frame: Refer to schedule.

C. Fabrication: Aluminum extrusions with factory clear lacquer finish.

D. Color: To be selected by Architect from manufacturer's standard range.

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.12 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.

B. Frame: 1-1/4 inch margin with countersunk screw mounting.

C. Fabrication: Steel frames and blades, with factory baked enamel finish.

D. Color: As shown on the drawings.

E. Color: To be selected by Architect from manufacturer's standard range.

F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

G. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.13 WALL GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Fixed grilles of 1/2 by 1/2 by 1/2 inch louvers.

B. Fabrication: Aluminum with factory clear lacquer finish.

C. Color: As shown on the drawings.

D. Color: To be selected by Architect from manufacturer's standard range.

E. Frame: 1-1/4 inch margin with countersunk screw mounting.

F. Frame: Channel lay-in frame for suspended grid ceilings.

G. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.14 LINEAR WALL REGISTERS/GRILLES

A. Type: Streamlined blades with 0 degree deflection, 1/8 by 3/4 inch (3.2 by 19 mm) on 1/4 inch (6 mm) centers.

B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.

C. Fabrication: Aluminum extrusions, with factory baked enamel finish.

D. Color: As shown on the drawings.

E. Color: To be selected by Architect from manufacturer's standard range.

F. Damper: Integral gang-operated opposed blade damper with removable key operator, operable from face.

2.15 LINEAR FLOOR SUPPLY REGISTERS/GRILLES

A. Type: Streamlined blades with 0 degree deflection, 1/8 by 3/4 inch (3 by 19 mm) on 1/4 inch (6 mm) centers, assembled on expanded tubes mandrel construction.

B. Frame: 1-1/4 inch (32 mm)heavy margin frame with countersunk screw mounting, and mounting frame.

C. Fabrication: Aluminum extrusions with factory baked enamel finish.

D. Color: As shown on the drawings.

E. Color: To be selected by Architect from manufacturer's standard range.

F. Damper: Integral gang-operated opposed blade damper with removable key operator, operable from face.

2.16 FLOOR SUPPLY REGISTERS/GRILLES

A. Individually adjustable blades, wide stamped border, single or double blade damper with set screw adjustment.

B. Fabricate of steel, welded construction, with factory baked enamel finish.

2.17 LOUVERS

A. Type: 4 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake.

B. Fabrication: 16 gage, 0.0598 inch thick galvanized steel welded assembly, with factory prime coat finish.

C. Color: As shown on the drawings.

D. Color: To be selected by Architect from manufacturer's standard range.

E. Fabrication: 12 gage, 0.1046 inch thick extruded aluminum, welded assembly, with factory prime coat finish.

F. Color: As shown on the drawings.

G. Color: To be selected by Architect from manufacturer's standard range.

H. Mounting: Furnish with interior flat flange for installation.

2.18 LOUVERED PENTHOUSE

A. Type: All welded assembly with 4 inch deep louvers, mitered corners, sheet aluminum roof, with factory prime coat finish.

B. Color: As shown on the drawings.

C. Color: To be selected by Architect from manufacturer's standard range.

2.19 ROOF HOODS

A. Fabricate air inlet or exhaust hoods in accordance with SMACNA (DCS).

B. Fabricate of galvanized steel, minimum 16 gage, 0.0598 inch base and 20 gage, 0.0359 inch hood, or aluminum, minimum 16 gage, 0.0598 inch base and 18 gage, 0.0598 inch hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory prime coat finish.

C. Fabricate louver penthouses with mitered corners and reinforce with structural angles.

D. Mount unit on minimum 12 inch high curb base with insulation between duct and curb.

E. Make hood outlet area minimum of twice throat area.

2.20 GOOSENECKS

A. Fabricate in accordance with SMACNA (DCS) of minimum 18 gage, 0.0598 inch galvanized steel.

B. Mount on minimum 12 inch high curb base where size exceeds 9 by 9 inch .

2.21 HOOD INTAKE AND RELIEF GRAVITY VENTILATOR:

A. Manufacturers:
1. Loren Cook Company
2. Greenheck Fan Corporation
3. American Coolair Corporation

B. General:
1. Low silhouette for intake applications with natural gravity or negative pressure system(s).
2. Performance ratings and factory testing to be in accordance with AMCA 511 and AMCA 550.
3. Suitable for non-ducted applications.
4. Equipment to bear permanently affixed manufacturer's nameplate listing model and serial number.

C. Hood and Base:
1. Material: Aluminum.
2. Hood Construction: Precision formed, arched panels with interlocking seams.
3. Vertical End Panels: Fully locked into hood end panels.
4. Curb Cap: Pre-punched mounting holes for installation.

D. Birdscreen:
1. Fabricate in accordance with ASTM B221 (ASTM B221M).
2. Construction: 1/2 inch Galvanized mesh.
3. Horizontally mounted across hood intake area.

E. Hood Support: Galvanized steel construction and fastened so hood can be removed completely from the base or hinged open.

F. Options/Accessories:
1. Roof Curbs:
a. Flat Roofs:
1) All fasteners/hardware that penetrate water and/or air vapor barriers and curbs are required to have holes pre-drilled and sealant injected prior to permanent installation of the fastener.
2) Welded, straight side curb with flashing flange and wood nailer.
3) Tabbed and riveted curb with 45 degree cant and wood nailer.
4) Welded curb with 45 degree cant and wood nailer.
b. Pitched Roofs: Welded, straight side curb with flashing flange and wood nailer.
1) Mounted on the roof with fan.
2) Material: Aluminum.
3) Insulation Thickness: 1 inch .
2. Provide extended base minimum 7 inch extension to base height making overall base 12 inches in height to prevent snow or moisture intake.
3. Curb Seal: Rubber seal between fan and roof curb.
4. Dampers:
a. Type: Gravity.
b. Factory designed to prevents outside air from entering back into building when fan is off.
c. Balanced for minimal resistance to flow.
d. Galvanized frames with pre-punched mounting holes.
5. Filters:
a. Mounted in open end racks for easy removal.
b. Washable 2 inch aluminum mesh designed to remove contaminants from the air.
6. Factory Finish: Thermo-setting polyester urethane.
7. Hood Insulation or Coating: Provide 1/2 inch fiberglass insulation lining or anti-condensate coating to prevent condensation and reduce sound levels.
8. Insect Screen:
a. Fabricate in accordance with ASTM B221 (ASTM B221M).
b. Construct of fine mesh aluminum.
c. Fitted to top of the throat to prevent entry of insects.
d. Coating: Thermo-setting polyester urethane.
9. Tie-Down Points: Aluminum brackets located on hood supports to secure fan in heavy wind applications.

2.22 SPUN ALUMINUM INTAKE AND RELIEF GRAVITY VENTILATOR:

A. Manufacturers:
1. Loren Cook Company
2. Greenheck Fan Corporation
3. American Coolair Corporation

B. General:
1. Provide low silhouette configuration for intake applications with natural gravity or negative pressure system.
2. Performance ratings and factory testing to be in accordance with AMCA 511 and AMCA 550.
3. Suitable for non-ducted applications.
4. Equipment to bear permanently affixed manufacturer's nameplate listing model and serial number.

C. Hood:
1. Material: Aluminum.
2. Internal structure constructed of galvanized steel.

D. Birdscreen:
1. Fabricate in accordance with ASTM B221 (ASTM B221M).
2. Construction: 1/2 inch galvanized mesh.
3. Horizontally mounted across hood intake area.

E. Housing:
1. Curb Cap:
   a. Type: Hinged.
   b. Construction: Aluminum.
   c. Integral deep spun inlet venturi with pre-punched mounting holes to ensure correct attachment to roof.
2. Windband:
   a. One piece spun aluminum construction with uniform, original material thickness throughout the housing.
   b. Include integral rolled bead for strength.

F. Options/Accessories:
1. Roof Curbs:
   a. Flat Roofs:
      1) Welded, straight side curb with flashing flange and wood nailer.
      2) Tabbed and riveted curb with 45 degree cant and wood nailer.
      3) Welded curb with 45 degree cant and wood nailer.
   b. Pitched Roofs: Welded, straight side curb with flashing flange and wood nailer.
   c. Mounted upon the roof with fan.
   d. Material: Aluminum.
   e. Insulation Thickness: 1 inch .
2. Curb Seal: Rubber seal between fan and roof curb.
3. Dampers:
   a. Type: Gravity.
   b. Factory designed to prevent outside air from entering back into building when fan is off.
   c. Balanced for minimal resistance to flow.
   d. Galvanized frames with pre-punched mounting holes.
4. Factory Finish: Polyester meeting or exceeding the chemical resistance properties of air dry phenolic (heresite).
5. Flashing Flange:
   a. Construction: Aluminum
6. Pre-punched holes for installation without a roof curb.Hood Insulation: Lined with 1/2 inch fiberglass insulation to prevent condensation and reduce sound levels.
7. Insect Screen:
   a. Fabricate in accordance with ASTM B221 (ASTM B221M).
   b. Fine mesh aluminum construction.
   c. Fitted to top of the throat to prevent entry of insects.
8. Tie-Down Points: Aluminum brackets located on hood supports to secure fan in heavy wind applications.
9. Reducer/Adapter:
   a. Type: Adapter.
   b. Material: Aluminum.

2.23 NON-POWERED GRAVITY UPBLAST ROOF VENTILATOR:

A. Manufacturers:
1. Loren Cook Company
2. Greenheck Fan Corporation
3. American Coolair Corporation

B. General:
1. Discharge air directly away from the mounting surface.
2. Roof mounted applications designed for use as a weatherproof outlet on vertical, high velocity exhaust systems.
3. Performance ratings and factory testing to be in accordance with AMCA 511 and AMCA 550.

C. Butterfly Dampers:
1. Material: Aluminum.
2. Designed to provide weather protection and prevent backdraft.
3. Blades with rubber seal.
4. Balanced for minimal resistance to flow.

D. Windband:
1. Construct from heavy gage, galvanized steel with reinforced and bolted seams.
2. Removable windband to gain access through the butterfly dampers.
3. Directs exhaust air away from mounting surface.

E. Curb Caps:
1. Aluminum construction.
2. Includes pre-punched mounting holes to ensure correct attachment to roof.

F. Options/Accessories:
1. Curb Seal: Rubber seal between fan and roof curb.
2. Finish: Thermo-setting polyester urethane.
3. Outlet Guards: Construct of expanded metal mounted in a steel frame to provide protection for non-ducted installations.
4. Magnetic Damper Latches: Minimizes damper flutter when unit is not exhausting.
5. Roof Curbs:
   a. Flat Roofs:
      1) Welded, straight side curb with flashing flange and wood nailer.
      2) Tabbed and riveted curb with 45 degree cant and wood nailer.
      3) Welded straight side curb with 45 degree cant and no wood nailer.
      4) Welded curb with 45 degree cant and wood nailer.
   b. Pitched Roofs: Welded, straight side curb with flashing flange and wood nailer.
   c. Mounted upon the roof with fan.
   d. Material: Aluminum.
   e. Insulation Thickness: 1 inch .
   f. Coating: Thermo-setting polyester urethane.
6. Tie-Down Points: Aluminum brackets located on hood supports to secure fan in heavy wind applications.

2.24 EXTRUDED ALUMINUM INTAKE VENTILATOR:

A. Manufacturers:
1. Loren Cook Company
2. Greenheck Fan Corporation
3. American Coolair Corporation.

B. Construction:
1. Extruded aluminum louvers, 0.081 inch thick, mitered at corners and welded for maximum strength.
2. Removable Hood: 0.05 inch , reinforced and braced for extra strength.
3. Base: 0.08 inch aluminum with mitered corners and seams with continuous weld for strength and tightness.
4. Bird Screen Galvanized welded wire fabricated in accordance with ASTM B221 (ASTM B221M).
5. Performance ratings and factory testing to be in accordance with AMCA 511 and AMCA 550.

C. Options/Accessories:
1. Hood Insulation: 1 inch batt fiberglass.
2. Cleanable filters.
3. Insect screen fabricated in accordance with ASTM B221 (ASTM B221M).
4. Coatings: Protective.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Coordination and project conditions.

B. Verify inlet and outlet locations.

C. Verify ceiling, wall systems are ready for installation.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.

C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Install diffusers to ductwork with air tight connection.

E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly. Refer to Section 23 33 00.

F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Division 09.

3.3 AIR OUTLET AND INLET SCHEDULE

A. Refer to contract drawings/plans.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION

SECTION 235100

BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Breeching and vents.
2. Combustion air intake.
3. Breeching and vents for boilers and water heaters.
4. Combustion air intake piping for boilers and water heaters.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 22 34 00 - Fuel-Fired Domestic Water Heaters: Water heaters using breeching, chimneys, and stacks.
3. Section 23 52 32 – Condensing Boilers

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI Z21.66 - Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
2. ANSI Z21.67 - Mechanically Actuated Automatic Vent Damper Device.
3. ANSI Z21.68 - Thermatically Actuated Automatic Vent Damper Devices.
4. ANSI Z95.1 - Oil Burning Equipment, Installation.

B. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
5. ASTM C401 - Standard Classification of Alumina and Alumina-Silicate Castable Refractories.

C. National Fire Protection Association:
1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
2. NFPA 54 - National Fuel Gas Code.
3. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment.
4. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances.

D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - Guide for Steel Stack Construction.
2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:
1. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances.
2. UL 127 - Factory-Built Fireplaces.
3. UL 378 - Draft Equipment.
4. UL 441 - Gas Vents.
5. UL 641 - Type L Low-Temperature Venting Systems.
6. UL 959 - Medium Heat Appliance Factory Built Chimneys.

1.3 DEFINITIONS

A. Breeching: Vent Connector.

B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.

C. Smoke Pipe: Round, single wall vent connector.

D. Vent: Portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

E. Vent Connector: Part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.4 DESIGN REQUIREMENTS

A. Design stacks above the roof for per local wind loading velocities

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittals procedures.

B. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breeching. Submit layout drawings indicating plan view and elevations

C. Product Data: Submit data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

D. Calculations: Submit flue vent calculations based upon submitted product data and shop drawings.

E. Product Data: Submit data on fans and accessories including fan curves with specified operating point plotted, power, RPM, and electrical characteristics and connection requirements.

F. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

1.6 QUALITY ASSURANCE

A. Provide factory built vents and chimneys used for venting natural draft appliances complying with NFPA 211 for fuel fired and NFPA 54 for gas fires and UL listed and labeled.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum two weeks prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Maintain water integrity of roof during and after installation of chimney or vent.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 BOILERS AND WATER HEATERS

A. Manufacturers:
1. Metal-Fab Inc. Model Corr/Guard
2. Other acceptable manufacturers offering equivalent products.
   a. Metalbestos
   b. CB Exhaust Solutions.

B. Flue shall be positive pressure, double wall metal stack, UL 1738 listed for a high efficiency, condensing, Category IV boiler.

C. Fabricate with 1 inch (25 mm) annular space. Inner wall shall be constructed of AL29-4C, minimum.015” thickness. Outer wall shall be constructed of Type 304 stainless steel, minimum.018” thickness

D. Accessories, UL labeled:
1. Ventilated Wall Thimble: Consists of wall penetration, vent flashing with spacers and storm collar.
2. Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.
3. Fittings: Elbows, wyes, expansion sections, barometric dampers, and accessories as required for a compete installation.

4. Joints: Seal with sealant as recommended by manufacturer.

2.2 COMBUSTION AIR INTAKE PIPING UNLESS NOTED OTHERWISE ABOVE

A. Galvanized steel: Refer to Spec Section 23 3100.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA AND SMACNA Guide for Steel Stack Construction.

B. Install breeching with minimum of joints. Align accurately at connections, with internal surfaces smooth.

C. Support breeching from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breeching, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size.

D. Pitch breeching with positive slope up from fuel-fired equipment to chimney or stack.

E. Coordinate installation of dampers and clean-outs.

F. Maximum Vent Horizontal Distance: 75 percent of vent vertical distance.

G. Where appliance requires draft hood or barometric control device, install manufacturer furnished listed devices in accordance with manufacturer's instructions and applicable code.

H. Install vent dampers, locating close to draft hood collar, and secured to breeching.

I. Level and plumb chimney and stacks.

J. Clean breeching, chimneys, and stacks during installation, removing dust and debris.

K. Install slip joints allowing removal of appliances without removal or dismantling of breeching, breeching insulation, chimneys, or stacks.

L. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breeching, breeching insulation, chimneys, or stacks

M. Provide minimum length of breeching to connect appliance to chimney.

N. Extend vent above roof in accordance with applicable code.

END OF SECTION

SECTION 235223

STEAM BOILERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Steam boilers.
2. Boiler controls.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 22 11 00 - Facility Water Distribution: Execution requirements for cold water piping connections to boilers specified in this section.
4. Section 22 11 23 - Facility Natural-Gas Piping: Execution requirements for natural gas piping connections to boilers specified in this section.
5. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
6. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolators for placement by this section.
7. Section 23 11 13 - Facility Fuel-Oil Piping: Execution requirements for fuel oil piping connections to boilers specified in this section.
8. Section 23 21 13 - Hydronic Piping: Execution requirements for hot water piping for piping connections to boilers specified in this section.
9. Section 23 22 13 - Steam and Condensate Heating Piping: Execution requirements for steam piping for piping connections to boilers specified in this section.
10. Section 23 51 00 - Breechings, Chimneys, and Stacks: Execution requirements for breeching, chimney, and stack connections to boilers specified in this section.
11. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to boilers specified in this section.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI Z21.13 - Gas-fired Low Pressure Steam and Hot Water Boilers.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. American Society of Mechanical Engineers:
1. ASME Section I - Boiler and Pressure Vessel Code - Power Boilers.
2. ASME Section IV - Boiler and Pressure Vessel Code - Heating Boilers.
3. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. Hydronics Institute:
1. H.I. Heating Boiler Standard - Testing and Rating Standard for Heating Boilers.

E. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. National Fire Protection Association:
   1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
   2. NFPA 54 - National Fuel Gas Code.
   3. NFPA 58 - Liquefied Petroleum Gas Code.

G. Underwriters Laboratories Inc.:
   1. UL 726 - Oil-Fired Boiler Assemblies.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit capacities and accessories included with boiler. Include general layout, dimensions, size and location of piping connections, fuel, electric and vent connections, electrical characteristics, weight and mounting loads.

C. Test Reports: Indicate boilers meet or exceed specified performance and efficiency. Submit results of combustion test.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Manufacturers Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.5 QUALITY ASSURANCE

A. Conform to ASME Section IV and ANSI Z21.13 Code and UL 726 for construction of boilers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

B. Boiler Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with H.I. Heating Boiler Standard.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept boilers and accessories on site in factory shipping packaging. Inspect for damage.

C. Protect boilers from damage by leaving packing in place until installation.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.

B. Furnish service and maintenance of boilers for one year from Date of Substantial Completion.

C. Provide emergency call back service at all hours for this maintenance period.

D. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

E. Perform maintenance work using qualified personnel under supervision and in direct employ of boiler manufacturer boiler manufacturer’s representative or original installer.

PART 2 PRODUCTS

2.1 CAST-IRON BOILERS

A. Manufacturers:
1. Fulton Classic ICS
2. Cleaver Brooks
3. Weil McLain

B. Product Description: (2) Fulton Classic ICS 10 hp Steam Boilers, Condensate Return

C. System, 3-phase burner, Steam Blowdown Tank, Chemical and water softening system, all mounted on an engineered factory skid.

D. Boiler Fabrication:
1. Assembly: Cast iron sections assembled with push nipples or gaskets and draw rods.
2. Furnish access for flue passages for cleaning and flame observation ports.
3. Structural Base: Aluminized steel lined with high temperature mineral fiber insulating panels.
4. Jacket: Glass fiber insulated steel jacket, finished with factory applied baked enamel.

E. Steam Boiler Trim:
1. ASME rated pressure relief valve, 15 psig.
2. Steam pressure gage, 0 to 30 psig.
3. Water column gage glass set with shutoff valves.
4. Low water cut-off to prevent burner operation when boiler water drops below safe level and boiler condensate return pump control to maintain water level by controlling pump operation.
5. Second low water cut-off.
6. Operating pressure controller for burner to maintain steam pressure setting.
7. High limit pressure control with manual reset for burner to prevent steam pressure from exceeding system pressure.
8. Low limit pressure control.

F. Accessories:
1. Manual surface blowdown kit
2. Non-fused disconnect switch
3. Panel mounted E-stop
4. Diagnostic display module
5. Boiler gauge kit
6. On/off solenoid feedwater valve
7. High water overflow protection kit
8. Steam stop valve
9. Stainless steel sampling cooler

G. Feedwater Condensate Return System:
1. Supply (1) Fulton Horizontal Feedwater/Condensate return tank for boiler mentioned above, Fulton Model 30, -Duplex return system consist of a tank & stand, two (2) Vertical multi-stage pumps, pump suction piping (isolation valve, strainer, and vibration isolator), water level sight glass, and level control, and CCT as identified below.
2. Non-fused disconnect switch
3. Stainless steel construction option
4. Electronic pump alternator
5. Steam injection preheat kit with pressure reducing valve and temperature regulator
6. Chemical injection quill
7. Continuous pump recirculation option

H. Blowdown Tank
1. Based on Fulton F-30 Blowdown Tank
2. ASME Section VIII Design and National Board registered
3. 75 PSIG Design
4. Heavy gauge carbon steel construction

5. Spinning action baffle plate design
6. 3 x 4 Handhole
7. Thermometer
8. Connections for inlet, outlet, drain, vent, cold water, sight glass, and pressure gauge
9. Thermostatic cooling tank
10. Site glass and pressure gauge

I. Water Softener System
1. Based on Fulton model FB-150-010S water softener system

J. Chemical Feed System
1. Provide manufacturer's chemical feed system

K. Boiler Fuel Burning System:
1. Burner Operation: modulating with low fire position for ignition.
2. Gas Burner: Adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off.
3. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after air flow proven and slight delay, allow gas valve to open.
4. Collector and draft hood.
5. Controls: Pre-wired, factory assembled electronic controls in control cabinet with flame scanner or detector, programming control, relays, and switches. Furnish pre-purge and post-purge ignition and shut down of burner in event of ignition pilot and main flame failure with manual reset.

PART 3 EXECUTION

3.1 INSTALLATION

A. Place manufacturer's pre-assembled skid system after transporting into boiler room. Perform pressure test on boiler after assembly in accordance with the following:
1. Pressure test before connecting fuel piping, electrical connections, and controls.
2. Install boiler drain and pressure gage.
3. Plug remaining openings.
4. Fill boiler with water and vent air.
5. Pressure test to 1-1/2 times working pressure for water boilers for 60 minutes with no leaks or manufacturer's recommendations.
6. Repair leaks and retest.
7. After successful test, drain and remove plugs from openings to be used for piping connections and controls.

B. Install boilers plumb and level, to plus or minus 1/16 inch over boiler base.

C. Maintain manufacturer's recommended clearances around and over boilers.

D. Install boiler skid on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than boiler base on each side.

E. Connect fuel piping in accordance with respective NFPA reference. Provide isolation valves at connection.

F. Arrange piping with clearances for burner removal and service.

G. Install the following piping accessories on natural gas piping connections.
1. Strainer.
2. Pressure gage.
3. Shutoff valve.
4. Check valve.
5. Pressure reducing valve.

H. Install discharge piping from relief valves and drain valves to nearest floor drain.

I. Install boiler trim and accessories furnished loose for field mounting.

J. Install electrical devices furnished loose for field mounting.

K. Install control wiring between boiler control panel and field mounted control devices.

L. Connect flue to boiler outlet, full size of outlet.

3.2 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform combustion test including boiler firing rate, over fire draft, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output. Perform test at minimum, [mid-range,] and high fire.

3.3 MANUFACTURER’S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer’s field services.

B. Start-up boilers according to manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

3.5 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate operation and maintenance procedures.

C. Furnish services for manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of boilers. Schedule training with Owner, provide at least 7 days notice of training date.

END OF SECTION

SECTION 235239

FIRE-TUBE BOILERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Condensing, gas-fired, firetube boilers, trim and accessories for generating hot water.

1.2 RELATED REQUIREMENTS

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

B. Division 03 - Concrete.

C. Division 08 - Openings.

D. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

E. Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment.

F. Section 23 0913 - Instrumentation and Control Devices for HVAC.

G. Section 23 2114 - Hydronic Specialties.

H. Section 23 2123 - Hydronic Pumps.

I. Section 23 2500 - HVAC Water Treatment.

J. Section 23 5100 - Breechings, Chimneys, and Stacks.

K. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.

L. Section 26 0526 - Grounding and Bonding for Electrical Systems

1.3 ABBREVIATIONS AND ACRONYMS

A. AGA: American Gas Association.

B. FMG: Factory Mutual Global.

C. IRI: Industrial Risk Insurers.

D. UL: Underwriters Laboratories Inc.

1.4 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. AHRI, BTS-2000

B. ASHRAE Std. 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

D. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.

E. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.

F. ASME B31.1 - Power Piping.

G. ASME B31.9 - Building Services Piping.

H. ASME BPVC - Boiler and Pressure Vessel Code.

I. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels.

J. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers.

K. ASTM A959 - Standard Guide for Specifying Harmonized Standard Grade Compositions for Wrought Stainless Steels.

L. CSA 4.9, ANSI Z2.1.13

M. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

N. NFPA 31 - Standard for the Installation of Oil Burning Equipment.

O. NFPA 54 - National Fuel Gas Code.

P. NFPA 70 - National Electrical Code.

Q. UL 726 - Oil-Fired Boiler Assemblies.

R. UL 795 - Commercial-Industrial Gas Heating Equipment.

1.5 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, technical product data, rated capacities of selected model, weights (shipping, installed and operating), installation and start-up instructions, and furnished accessory information. Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.

B. Shop Drawings: Vibration isolation and seismic restraint requirements; approved by Architect. For boiler, standard boiler trim and accessories.
   1. End Assembly Drawing: Detail overall dimensions, connection sizes, connection locations, and clearance requirements.
   2. Wiring Diagrams: Detail electrical requirements for the boiler including ladder type wiring diagrams for power, interlock and control wiring. Clearly differentiate

between portions of wiring that are factory installed and portions to be field installed.

C. Certificate of Product Rating: Submit AHRI Certificate indicating Thermal Efficiency, Combustion Efficiency, Materials of Construction, Input, and Gross Output conform to the design basis.

D. Thermal efficiency curves: Submit thermal efficiency curves between and including minimum and maximum rated capacities, for return water temperatures ranging from 80°F to 180°F.

E. Water side pressure drop curve.

F. Flue gas temperature curves: Submit flue gas temperature curves for minimum and maximum boiler capacity, for return water temperatures ranging from 80°F to 160°F.
1. If submitted flue gas temperatures or excess O2% levels, minimum or maximum inputs are different from that of the basis of design manufacturer and model, the manufacturer shall be responsible for draft calculations and potential costs associated with reselection of the flue gas exhaust vent system.

G. ASME "H" Stamp Certification and Report: Submit "H" stamp certificate of authorization as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

H. Manufacturer's Inspection Report: Submit authorized boiler inspection prior to shipment.

I. Field quality-control test reports: Start-up by a factory authorized personnel.

J. Manufacturer's Field Start-up Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.
1. Indicate compliance with specified performance and efficiency.
2. Provide results of the following combustion tests:
    a. Boiler firing rate.
    b. Over fire draft.
    c. Gas flow rate.
    d. Heat input.
    e. Burner manifold gas pressure.
    f. Percent carbon monoxide.
    g. Percent oxides of nitrogen.
    h. Percent oxygen.
    i. Percent excess air.
    j. Flue gas temperature at outlet.
    k. Ambient temperature.
    l. Net stack temperature.
    m. Percent stack loss.
    n. Percent combustion efficiency.
    o. Heat output.

K. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

L. Manufacturer's Instructions: Indicate assembly, support details, connection requirements,

M. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms regularly engaged in the manufacture of condensing hydronic boilers with welded steel pressure vessels. The manufacturer must manufacture pressure vessels in an ASME-certified facility wholly owned by the manufacturer. The specifying engineer, contractor and end customer must have the option to visit the factory to witness test fire and other relevant procedures.

B. 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.

C. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code, Section IV “Heating Boilers”, for a maximum allowable working pressure of 160 PSIG.

D. CSD-1 Compliance: The boiler shall comply with ASME Controls and Safety Devices for Automatically Fired Boilers (CSD-1).

E. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to “Gas and Oil Fired Boilers - Minimum Efficiency Requirements.”

F. UL Compliance: Boilers must be tested for compliance with UL 795, “Standard for Commercial-Industrial Gas Heating Equipment.” Boilers shall be listed and labeled by a testing agency acceptable to the authorities having jurisdiction.

G. AHRI Compliance: Boilers shall be tested and rated according to the BTS-2000 test standard and verified by AHRI.

H. The equipment shall fit within the allocated space, leaving ample allowance for maintenance and inspection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.8 WARRANTY

A. Standard Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for the Pressure Vessel and Heat Exchanger: The boiler manufacturer shall warranty against failure due to:
      a. Flue gas condensate corrosion, and/or defective material or workmanship for a period of ten (10) years, non-prorated, from the date of shipment from the factory.

b. Thermal shock for the lifetime of the boiler.

2. Warranty Period for the Burner: The boiler manufacturer shall warranty the burner against defective material or workmanship for a period of five (5) years, non-prorated, from the date of shipment from the factory.
3. Warranty Period for all other components: The boiler manufacturer will repair or replace any part of the boiler that is found to be defective in workmanship or material within eighteen (18) months of shipment from the factory or twelve (12) months from start-up, whichever comes first.
4. Warranties are only valid provided the boiler is installed, controlled, operated and maintained in accordance with the Installation, Operation and Maintenance Manual.

PART 2 PRODUCTS

2.1 CONDENSING GAS BOILER – 10:1 TURNDOWN

A. Manufacturers
1. Fulton - Endura
2. Aerco – Benchmark Series
3. Lochinvar - Crest
4. Cleaver-Brooks – ClearFire-CE Series

B. The boiler manufacturer shall have the capability to construct an engineered hydronic system, skid mounted, for the above referenced boilers incorporating single point electrical, supply water, return water, fresh water make up, fuel, and drain. The boiler manufacturer shall have the engineering capabilities for all aspects of the mechanical, electrical and control design of the skidded system.

2.2 CONSTRUCTION

A. Description: Factory-fabricated, -assembled, and -pressure tested, stainless steel firetube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including flue gas vent; combustion air intake connections, water supply, water return, condensate drain, and controls. The boiler, burner and controls shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping. Closed-loop water heating service only.

B. Heat Exchanger: The heat exchanger is defined as the surfaces of the pressure vessel where combustion gases transfer heat to the hydronic fluid.
1. The boiler shall be a firetube design, such that all combustion chamber components are within water-backed areas. Watertube boilers will not be accepted.
2. Heat transfer capability shall be maximized via the use of corrugated firetubes. The corrugation process shall not remove any material from the tubes. Finned, twisted tape, or coil type tube inserts negatively impact ease of maintenance and will not be accepted.
3. Material: The heat exchanger furnace, tubesheets, and firetubes shall be constructed of stainless steel.
a. Heat exchangers constructed of cast aluminum, mild steel, cast iron or copper finned tube materials are not accepted.

C. Exhaust manifold shall be minimum 0.5” thick stainless steel, ASME designation SA-351 CF3M, and shall be a water-backed design to enhance heat transfer. Dry-back style flue gas condensate collection pan exhaust manifolds are not accepted.

D. Pressure Vessel: Design and construction shall be in accordance with Section IV of the ASME Code for heating boilers.
1. The shell shall be minimum 0.375” thick steel, SA-53B ERW.
2. The top head shall be a minimum 0.50” thick steel, SA-790 or SA-516 Grade 70.
3. The pressure vessel shall be a counter-flow design with internal water-baffling plates.
4. The boiler return and supply water connections shall be 150# ANSI flanged. The water connections shall not be designed to support an external structural load from the piping system.
5. The water volume of the boiler shall not be less than the value shown on the boiler schedule.
6. The maximum water pressure drop across the boiler inlet and outlet connections shall not exceed values included on the boiler schedule.

E. Fuel/Air Mixture Combustion System: Air and gas pre-mix on the suction side of the fan.
1. Fuel/Air mixture will be controlled by combustion air fan speed and gas valve. Fuel flow shall be controlled by either a servo-motor actuated butterfly valve or zero governor negative regulator system.

F. Burner: Standard natural gas, forced draft, woven fiber mesh design.
1. Turndown: Shall be no less than ten to one
2. Excess Air: The burner shall operate at no greater than 8.0% excess O2 over the entire modulation range to maximize seasonal combustion and thermal efficiencies.
3. NOx Emissions: When operating on natural gas, the burner shall maintain a level of <20 ppm over the complete combustion range at a 3% O2 correction.

G. Blower: The boiler shall include a variable-speed, centrifugal fan to operate during the burner firing sequence, pre-purge, and post purge sequence for the combustion chamber.

H. Main Fuel Train:
1. A factory mounted fuel train shall be supplied. The fuel train shall be fully assembled and enclosed within the boiler cabinet, complete with factory mounted and wired high and low gas pressure switches in compliance with CSD-1.

I. Ignition: Direct spark ignition with transformer. A UV scanner shall be utilized to ensure precise communication of flame status back to the flame programmer. Flame rods are not accepted.

J. Boiler Enclosure:
1. Cabinet: Jacketed steel enclosure with left hinged full height front access door, fully removable latching access panels, mounted on a steel skid with steel plate decking.
2. Control Enclosure: NEMA 250, Type 1.
3. Finish: Cabinet shall be powder coated, pressure vessel assembly shall be painted.
4. Combustion Air: Factory mounted air filter directly coupled to the blower inlet.

K. Rigging and Placement: The boiler shall include lifting eyes and fork hole accessibility for rigging.

2.3 TRIM

A. Safety Relief Valve: ASME rated.

B. Pressure and Temperature Gauge: Minimum 3-1/2” diameter, combination pressure and temperature gauge.

C. Flue Gas Condensate Drain Trap: A flue gas condensate drain trap shall be provided to prevent positive pressure exhaust gases from entering the boiler room.

D. Flue Gas Condensate Neutralization: pH neutralization shall be provided.

2.4 CONTROLS

A. The boiler electrical control panel shall include the following devices and features:
1. Push button or touch screen control display factory mounted on the front cabinet panel door.
a. The control display shall serve as a user interface for programming parameters, boiler control and monitoring; and shall feature a screen saver, boiler status, configuration, history and diagnostics.
2. Controls Transformers: 120VAC, 24 VDC, 12 VDC.
3. Flame safeguard control with 9 combustion fuel/air load profile points.
4. All standard controls shall be factory mounted and wired according to UL requirements.

B. Burner Operating Controls: To maintain safe operating conditions, factory mounted and wired burner safety controls limit burner operation:
1. High Limit: A manual reset mechanical Aquastat device shall stop the burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cut Off: UL 353 certified CSD-1 compliant electronic probe type mounted in the pressure vessel shall prevent burner operation on low water conditions. Device shall be manual reset type that automatically resets to the “closed” position after safe conditions have been restored and allows the boiler to restart automatically.
3. Air Safety Switch: Prevent operation unless sufficient combustion air is proven.
4. Blocked Exhaust: Prevent operation in the event of a blocked flue gas exhaust stack.

C. Boiler Operating Controls:
1. Inlet Water Temperature Monitoring.
2. Combustion Air Temperature Monitoring.
3. Flue Gas Exhaust Temperature Monitoring: Sensor probe shall be stainless steel.
4. Proportional Integral Derivative (PID) temperature load control capability for hydronic and domestic hot water in standalone or lead/lag operation.
5. Operating temperature sensor for automatic start and stop.
6. Outdoor air temperature (OAT) reset controls with warm weather shutdown:
a. OAT reset shall automatically adjust the setpoint according to changes in the outdoor temperature, and disable the boilers above a warm weather shutdown temperature.

b. The boiler manufacturer shall provide an OAT sensor.
c. The temperature sensor shall be field installed in an outdoor area not exposed to direct sunlight or the exhaust of other mechanical equipment, and wired the boiler controller.
d. The control shall be field programmed with the outdoor reset schedule.

7. Variable Speed System (Secondary) Pump Control:
   a. When installed in a variable primary flow configuration, the boiler controller shall provide the capability to control two variable speed hydronic heating pumps. One pump shall be duty, and one standby.
   b. The duty system pump shall be enabled upon the outdoor air temperature dropping below the warm weather shutdown temperature. Pumps shall be automatically rotated.
   c. Variable speed signal shall be provided to modulate pump speed according to hydronic heating loop Delta-T. A user selectable parameter allows for Delta-P in place of Delta-T.
8. Motorized isolation valve control:
   a. Upon heat demand for the boiler, the control shall provide an enable/open signal.
   b. After the burner is disabled and upon the heat exchanger delta-T dropping to a user programmable delta-T, the signal will be disabled.
   c. In variable primary arrangements, the control shall hold the lead boiler isolation valve open at all times.

D. Lead/Lag Control of Modular (Multiple) Boiler Plants: Lead/Lag capabilities shall be integral to the boiler controller for up to 10 boilers installed in the same hydronic loop and shall not require an external panel.

E. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.
1. Communication Protocol: A Modbus communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.
   a. A BACnet MSTP and IP protocol communication gateway shall be provided. The BACnet gateway is field installed on a boiler. Additional boilers in the lead/lag system shall not require a dedicated BACnet gateway for the BAS to monitor status. A communication point mapping list shall be provided.

2.5 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory installed switches, controllers, transformers, and other devices will have a single-point field connection.
1. Enclosure: NEMA 250, Type 1.
2. Wiring: Numbered and color-coded matching wiring diagram.
3. Factory wiring exterior of an enclosure to be in a metal raceway.
4. Field power interface shall be to lugs.
5. Branch power circuit to each motor and controls with disconnect switch or circuit breaker.
6. Overcurrent Protection: Each motor.

2.6 VENTING

A. Refer to Section 23 5100.

B. The boiler shall be capable of operating with a stack effect not exceeding -0.10” W.C. and a combined air intake and exhaust venting pressure drop not exceeding 100 equivalent feet intake and exhaust.

C. Combustion Air Intake: It shall be acceptable to either direct vent the boiler using sealed combustion by drawing combustion air in from the outdoors

D. Condensate drain piping must be Schedule 40 CPVC.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Each boiler shall be installed and operated in a functioning hydronic system, inclusive of venting, as part of the manufacturing process. A factory test fire report corresponding to the boiler configuration shall be included with each boiler.

PART 3 EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after satisfactory conditions have been verified.

3.2 INSTALLATION

A. Install boilers level on concrete base, minimum 3.5 inches high. Concrete base is specified in Division 23 Section “Common Work Results for HVAC,” and concrete materials and installation requirements are specified in Division 03.

B. Install gas-fired boilers according to NFPA 54. Equipment and materials shall be installed in an approved manner and in accordance with the boiler manufacturer’s installation requirements.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with the boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

C. Connect gas piping to boiler gas train inlet with isolation valve and union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

D. Connect hot water supply and return water connections with shutoff valve and union or flange at each connection.

E. Install piping from safety relief valves to the nearest floor drain or local equivalent approved by local code.

F. Install piping from flue gas condensate drain connection to the condensate drain trap and to the nearest floor drain.

G. Boiler Venting:
   1. Install flue venting and combustion air-intake.
   2. Connect to boiler connections, flue size and type as recommended by the manufacturer.

H. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

I. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

3.4 FIELD QUALITY CONTROL

A. See Division 01 - General Requirements.

B. Perform tests and inspections and prepare test reports.
   1. After boiler installation is completed, the manufacturer shall provide the services of a field representative to inspect components, assemblies, and equipment installations, including connections and provide startup of the boiler and training to the operator.
   2. Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boilers and piping. Obtain certification for completed boiler units, deliver to Owner, and obtain receipt.

C. Tests and inspections:
   1. Perform installation and startup checks according to manufacturer’s written instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 CLOSEOUT ACTIVITIES

A. See Division 01 - General Conditions.

B. Train operating personnel in operation and maintenance of units.

C. Provide the services of manufacturer's field representative to conduct training.
   1. Demonstrate operation of all safety controls.
   2. Demonstrate operation of the boilers over the entire firing range of the burners.

3.6 MAINTENANCE

A. See Division 01 - General Requirements.

END OF SECTION

SECTION 236413

AIR COOLED CHILLERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes chiller package, charge of refrigerant and oil, controls and control connections, chilled water connections, condenser water connections, refrigerant connections, auxiliary water connections, starters.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
5. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for chillers specified in this section.
6. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and condenser water piping for placement by this section.
7. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for piping specialties for placement by this section.
8. Section 23 23 00 - Refrigerant Piping: Product requirements for refrigerant piping for placement by this section.
9. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection to chillers specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
1. ARI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. American Society of Mechanical Engineers:
1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 DEFINITIONS

A. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

B. Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate valves, strainers, and thermostatic valves required for complete system.

C. Product Data: Submit rated capacities, weights, specialties and accessories, electrical requirements, wiring diagrams, and control diagrams.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include startup instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements including those furnished but not produced by manufacturer.

F. Manufacturer’s Field Reports: Submit start-up report for each unit. Indicate results of leak test and refrigerant pressure test.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

1.6 QUALITY ASSURANCE

A. Conform to ARI 550/590 code for testing and ratings.

B. Performance Ratings: Coefficient of Performance (COP) and Integrated Part-Load Value (IPLV) not less than prescribed by ASHRAE 90.1.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept chillers on site in factory packaging. Inspect for damage.

C. Protect indoor chillers from weather by storing under roof.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty to include coverage for compressor; materials and labor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The Trane Company

B. Other manufacturers offering similar product:
1. York - JCI
2. Carrier

2.2 EVAPORATOR

A. The evaporator shall be built in accordance with ANSI/ASHRAE 15- Safety Code for Mechanical Refrigeration. Design, test, and stamp evaporator refrigerant side for 200 psig (1379 kPa) working pressure in accordance with ANSI/ASME SEC 8.

B. Evaporator tubes shall be copper, internally enhanced and externally finned to achieve maximum efficiency. The nominal tube wall thickness shall be 0.025 inches.

C. Water boxes shall be designed for 150 psig maximum waterside working pressure and shall be flanged and gasketed for easy removal and access to the tubes. The water boxes shall have grooved-type water connections for easy field chilled water and condenser water connections and have proper orientation as referenced in the scheduled drawings.

D. Units with multi-stage compressors shall incorporate an interstage flash vessel economizer in the refrigerant cycle.

E. Factory insulation will be 1-1/4" insulation Armaflex II or equal (k=0.28) and cover the evaporator, water boxes and motor housing. Factory installed foam insulation will be used on the suction line, liquid level sensor and oil return system assembly. Heaters with thermostat shall be provided for the evaporator barrel assembly.

2.3 AIR-COOLED CONDENSER AND FANS

A. Construct condenser coils with mill galvanized steel fan sections and coil side baffles. Legs shall be heavy gauge mill galvanized steel. Copper tubes shall be mechanically

expanded into aluminum fins. Coils shall be helium leak and pressure tested with 400 psig dry air, shipped and pressurized with dry nitrogen.

B. Provide quiet, direct-drive, multi-bladed propeller fans. Fans shall provide uniform air distribution through the coil and venturi fan orifices to optimize efficiency. Entire fan assembly shall be statically and dynamically balanced and fan assembly shall be either painted or zinc-coated steel. Fan guard shall be either PVC, chrome, or zinc coated.

C. Condenser fans shall have permanent magnet motors with integrated drive to provide variable speed fan control on all fans. Wide ambient unit shall start between 0.0F and 125F ambient outdoor conditions.

2.4 REFRIGERANT CIRCUIT

A. Unit shall be configured for use with R-513A refrigerant.

B. All units shall have 2 independent refrigerant circuits, each with a separate compressors. If manifolded compressors are provided on a circuit, then individual compressor warranties must be provided for each compressor on the circuit.

C. Provide for each refrigerant circuit
1. Suction service valve
2. Discharge service valve
3. Liquid line shutoff valve
4. Filter drier

2.5 CONTROLS

A. The chiller(s) shall be controlled by a microprocessor-based, proportional and integral controller to show water and refrigerant temperatures, refrigerant pressures and diagnostics. A dedicated chiller control panel with a non-coded display is to be supplied with each chiller by the chiller manufacturer. The controller shall provide chiller capacity control in response to the leaving chilled water temperature.

B. The chiller control panel shall utilize the following components to automatically take action to prevent unit shutdown due to abnormal operating conditions which will perform as follows:
1. High pressure limit that is set 10% lower than factory pressure switch that will automatically unload the compressor to help prevent a high pressure condenser control trip. One switch is required for each compressor and indicating light shall also be provided.
2. Current limit setpoint that is set to 120% of compressor RLA that will automatically unload the compressor to help prevent an overcurrent trip. One protector is required for each compressor and indicating light shall also be provided.
3. Low refrigerant temperature limit that will automatically unload the compressor to help prevent a low evaporator temperature trip.

C. If the chiller runs in any of the abnormal operating conditions, the chiller will continue to run, in an unloaded state, and will continue to produce chilled water in an attempt to meet the cooling load. However, if the chiller reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset is required. Once the "near trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.

D. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays, and switches. The panel shall be a complete system for stand-alone chiller control and include controls to safely and efficiently operate the chiller.

E. Manufacturer shall provide a compressor that is capable of unloading to an infinite amount of positions in order to provide water temperature accuracy of +/- 0.5F. In the event that the compressor unloads to finite steps, the manufacturer shall provide eight (8) or more steps of unloading on each compressor or provide HGBP.

F. The chiller control panel is to be provided with the following digital type pressure readouts:
1. Evaporator refrigerant pressure
2. Condenser refrigerant pressure

G. The front of the chiller control panel shall be capable of displaying the following clear language as standard:
1. Entering and leaving evaporator water temperature
2. Entering and leaving condenser water temperature
3. Chilled water setpoint
4. Electrical 3 phase current limit and percent RLA setpoint
5. Electrical 3 phase amp draw
6. Chiller operating mode
7. Condenser refrigerant temperature
8. Elapsed time and number-of-starts counter
9. Chiller compressor run status relay
10. Diagnostics with time and date stamp
11. The control panel display shall identify the fault, indicate date, time, and operating mode at time of occurrence, and provide type of reset required and a help message. The historic diagnostic report shall display the last 20 diagnostics with their times and dates of occurrence

H. Digital communication to the building management system shall consist of a BacNet certified interface.

I. The chiller shall provide the following points for system control and monitoring:
1. A relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
2. A relay output that shall energize whenever the unit is operating in a limit mode for an extended time period.
3. An analog input to control leaving chilled water temperature setpoint based upon a 4-20ma or 0-10 VDC signal from a building automation system.

J. The chiller control panel shall provide a programmable soft load to prevent the chiller from achieving full capacity during the pulldown period by imposing a ramped current limit, or a temperature pulldown rate. Either can be adjusted to limit how fast the chiller can load after an initial startup.

K. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

2.6 COMPRESSOR STARTERS

A. The compressors on the ACR chillers are driven by Variable Frequency Drives (VFD). The drives are hybrid cooled by both water/glycol through the chillplate to cool the power electronics and also forced air for other components in the drive. The drives include

custom programming for Trane application to provide chiller specific protections and stable compressor operation across the operating map. Protections include compressor overload, low or high line voltage, output phase loss, input phase loss, drive overheating, and more. The drives communicate over a serial connection (Modbus) to the Tracer® Symbio(TM) 800 unit control module for run-time control, real-time data feedback, and diagnostics.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install the following piping accessories on evaporator chilled water piping connections.
   1. On inlet:
      a. Thermometer well for temperature controller.
      b. Thermometer.
      c. Strainer.
      d. Flow switch.
      e. Flexible pipe connection.
      f. Pressure gage.
      g. Shut-off valve.
   2. On outlet:
      a. Thermometer.
      b. Flexible pipe connection.
      c. Pressure gage.
      d. Shut-off valve.

B. Arrange piping for easy dismantling to permit tube cleaning.

C. Install chiller accessories furnished loose for field mounting.

D. Install electrical devices furnished loose for field mounting.

E. Install control wiring between chiller control panel and field mounted control devices.

F. Provide connection to electrical service. Refer to Section 26 05 03.

3.2 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Furnish cooling season start-up, winter season shutdown service, for first year of operation. When initial start-up and testing takes place in winter and machines are to remain inoperative, repeat start-up and testing operation at beginning of first cooling season.

3.3 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.

B. Furnish services of factory trained representative for minimum of one day to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.

C. Furnish initial charge of refrigerant and oil.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

3.5 DEMONSTRATION AND TRAINING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate system operations and verify specified performance. Demonstrate low ambient operation during winter testing for air-cooled condensers.

END OF SECTION

SECTION 237415

AIR HANDLING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
1. Air Handling Units.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for chillers specified in this section.
5. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and condenser water piping for placement by this section.
6. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for piping specialties for placement by this section.
7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection to chillers specified by this section.

1.2 REFERENCES:

A. Material standards shall be as specified or detailed hereinafter and as follows:
1. AMCA Publication 99 – Standards Handbook
2. AMCA Publication 311 – Certified Ratings Program - Product Rating Manual For Fan Sound Performance.
3. AMCA Standard 300 – Reverberant Method for Sound Testing of Fans.
4. AMCA Standard 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
5. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.
6. AMCA Standard 500-L – Laboratory Methods of Testing Louvers for Rating.
7. ANSI/ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
8. ANSI/ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
9. ANSI/AMCA Standard 204 – Balance Quality and Vibration Levels for Fans.
10. ANSI/AMCA Standard 210 – Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
11. ANSI/AHRI Standard 1060 – Rating Air-to-Air Energy Recovery Ventilation Equipment.
12. ANSI/ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
13. ANSI/NEMA MG 1 – Motors and Generators.
14. AHRI Standard 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment.
15. AHRI Standard 410 – Forced-Circulation Air-Cooling and Air-Heating Coils.
16. ASHRAE 52.1 – Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
17. ASHRAE 84 – Method of Testing Air-to-air Heat Exchangers.

18. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
19. ASTM E477 – Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
20. NFPA 70 – National Electrical Code®.
21. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilation Systems.
22. UL 555S – Standard for Safety Smoke Dampers.
23. UL 900 – Standard for Safety Air Filter Units.
24. UL 1812 – Standard for Safety Ducted Heat Recovery Ventilators.
25. UL 1995 – Standard for Safety Heating and Cooling Equipment.

1.3 ABREVIATIONS

A. The following abbreviations pertain to this section:
1. ABMA – American Bearing Manufacturers Association.
2. AC – Alternating current.
3. AF – Air foil.
4. AI – Analog input.
5. AMCA – Air Movement and Control Association International, Inc.
6. ANSI – American National Standards Institute.
7. AO – Analog output.
8. AHRI – Air-Conditioning, Heating, and Refrigeration Institute.
9. ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers.
10. ASTM – American Society for Testing and Materials.
11. dB – Decibels.
12. DDC – Direct digital controls.
13. DOP – Dioctyl phthalate aerosol.
14. DWDI – Double width, double inlet.
15. EATR – Exhaust air transfer rate.
16. EMT – Electrical metal tubing.
17. EPAct – Energy Policy Act.
18. ETL – Electrical Testing Laboratories.
19. FC – Forward curved.
20. FLA – Full load amps.
21. FM – Factory Mutual.
22. FMC – Flexible metal conduit
23. FOB – Freight on board.
24. fpm – Feet per minute.
25. GFCI – Ground fault circuit interrupter.
26. IRI – Industrial Risk Insurers.
27. ISO – International Organization for Standardization.
28. MERV – Minimum efficiency report value.
29. MOP – Maximum overcurrent protection.
30. MPT – Male pipe thread.
31. NEC – National Electric Code.
32. NEMA – National Electrical Manufacturers Association.
33. NFPA – National Fire Protection Association.
34. NIST – National Institute of Standards and Technology.
35. ODP – Open drip proof.
36. OSHA – Occupational Safety and Health Administration.
37. psig – Pounds per square in gage.
38. SMACNA – Sheet Metal and Air-Conditioning Contractors' National Association.
39. SWSI – Single width, single inlet.
40. TEFC – Totally enclosed, fan cooled.

41. UL – Underwriters Laboratory.
42. VFD – Variable frequency drive.

1.4 DEFINITIONS

A. Thermal break shall be defined as a thermal break that ensures no member on the exterior of the unit, including fasteners, has through metal contact with any member on the interior of the unit, including fasteners.

B. Wall assemblies shall include all unit wall panels around the air tunnel perimeter, all channels exposed to both the interior and exterior of the unit, and all removable wall access panels.

C. Door assemblies shall include interior and exterior unit door panels, door frames, and door channels.

D. Roof assemblies shall include exterior unit roof panels, interior unit ceiling panels, and all roof channels exposed to both the interior and exterior of the unit.

E. External pipe cabinet assemblies shall include all cabinet wall panels, exterior cabinet roof panels, interior cabinet ceiling panels, all channels exposed to both the interior and the exterior of the unit, and interior and exterior cabinet door panels, door frames, and door channels.

1.5 SCOPE OF WORK

A. The AHU Manufacturer’s work shall include, but is not necessarily limited to the following:
1. Furnish a complete set of submittals as described hereinafter.
2. Provide AHUs fully factory assembled with the exception of unit splits as required for shipping or installation requirements as indicated on the schedule and drawings. Disassembled AHU components provided to the Mechanical Contractor for field assembly as built-up AHUs shall not be acceptable. As shipped from the AHU Manufacturer, AHUs shall meet the performance requirements shown on the equipment schedule. Units shall be for indoor or outdoor application and shall have all components and options as indicated on the schedule or drawings. Furthermore, units shall be constructed as detailed hereinafter. Field-provide components and options shall be unacceptable unless otherwise noted.
3. Provide all labor, materials, and equipment necessary for the complete engineering, production, factory assembly, factory testing, packaging, and delivery of the custom AHUs and their related equipment. Provide high voltage components, factory engineered, mounted and wired.
4. Permit the Owner and Engineer to inspect as herein described and to witness performance tests to ensure good product quality and compliance with these specifications.
5. Factory test all AHUs as detailed herein and on the schedule.
6. Provide a factory-authorized service representative employed by the AHU Manufacturer to supervise installation and start-up of the units as herein described. Installation shall be performed by the Mechanical Contractor employed by the Owner.
7. Provide Owner's Manual, complete operating instructions.

B. Contractor Shall:
1. Coordinate all work associated with the AHU installation. Schedule with the AHU Manufacturer for a factory-authorized service person employed by the AHU Manufacturer to supervise unit installation. Clear area where unit is to be set of

any construction materials or debris. Ensure equipment curbs or support platforms are level prior to setting the units. Hoist and set units in their proper position. Use spreader bars to hoist the unit (sections) to avoid damaging units. If units ship in multiple sections, provide all labor and equipment for placing and field joining sections.

2. Provide all final chilled water, hot water, glycol water, and drain piping connections.
3. Remove all foreign objects and thoroughly clean the interior and exterior surfaces of the units with a mild detergent (soap and water). Do not use any abrasives or solvents without first consulting the AHU Manufacturer.
4. Install filter media in filter frames. Operating units without filter media is strictly prohibited.
5. Perform unit start up as detailed herein under the guidance and supervision of a factory-authorized service person employed by the AHU Manufacturer.

1.6 SUBMITTALS

A. No equipment shall be fabricated or delivered until the receipt of approved shop drawings from the Owner or Owner's approved representative.

B. AHU Manufacturer shall provide the following information with each shop drawing/product data submission:
   1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, support locations, and weights. Drawings shall also indicate all electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations. Each component of the unit shall be identified and shall include physical dimensions and material of construction.
   2. Panel-to-panel joint and corner details and panel-to-roof details, all showing thermal breaks.
   3. All performance data, including capacities and airside and waterside pressure drops, for components. AMCA-certified fan curves shall be provided with specified operating point clearly plotted. AMCA-certified sound power level data for fan inlet and outlet at fan rated capacity shall be provided. EATR and the amount of outside air transferred to the exhaust air shall be provided for each energy wheel. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, and 4000 Hz based on AHRI 260 fan in unit testing.
   4. Brand and model of fans, fan motors, coils, air filters, dampers, silencers, total energy recovery wheels, variable frequency drives, and unit DDC controllers being furnished.

C. The AHU Manufacturer shall provide appropriate sets of submittals as referenced in the General Conditions and shall submit to the Owner electronic copies of the IOM.

1.7 WARRANTY AND SERVICE

A. The AHU Manufacturer shall have a service department located within 100 miles of the job site.

PART 2 PRODUCTS

2.1 AIR HANDLING UNITS – ROOFTOP AHU units

A. Manufacturers:
1. Trane Performance Climate Changer
2. Daikin
3. York/JCI
4. Substitutions: Division 01

B. General:
1. Furnish and install exterior grade double wall air handler(s). All internal components specified in the air handling unit schedule will be factory furnished and installed. Unit(s) will be completely factory assembled. The units cooling, heating, ventilating capacity and performance will meet or exceed that shown on the schedule.
2. Unit layout and configuration shall be as defined in project plans and schedule.
3. Provide an integral base frame to support all sections of unit and raise unit for proper trapping. Refer to 230548 for roof curb requirements.

C. Unit Casing:
1. Unit manufacturer shall ship separate segments so unit can be broken down for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 500-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
2. Unit casing panels shall be 2” double-wall construction, with solid galvanized exterior and solid interior liner galvanized interior, to facilitate cleaning of unit interior.
3. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 $Hr*Ft^{2}*°F/BTU$.
4. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
5. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.
6. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

D. External Finish / Painting
1. All external surfaces of the casing, support framing and accessories shall be prepared and painted. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Paint shall be standard slate gray color.

E. Access Doors:
1. Access doors shall be 2” double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.
2. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.

3. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
4. Handle hardware shall be designed to prevent unintended closure.
5. Access doors shall be hinged and removable without the use of specialized tools.
6. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.

F. Primary Drain Pans:
1. All cooling coil sections shall be provided with an insulated, double-wall, stainless steel drain pan.
2. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements.
3. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
4. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.
5. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2” beyond the base to ensure adequate room for field piping of condensate traps.
6. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.
7. Drain pans shall be provided for heating coils, access sections, and mixing sections as indicated in the plans.

G. Fans:
1. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25% and 100% of design RPM. If fans are not factory-tested for vibration and alignment, the contractor shall be responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.
2. Belt-driven fans shall be provided with grease lubricated, self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9. Lubrication lines for both bearings shall be extended to the drive side of the AHU and rigidly attached to support bracket with zerk fittings. Lubrication lines shall be a clear, high-pressure, polymer to aid in visual inspection. If extended lubrication lines are not provided, manufacturer shall provide permanently lubricated bearing with engineering calculations for proof of bearing life.
3. Fans shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with 2-inch isolators. A flexible connection (e.g. canvas duct) shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External

isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

4. Belts shall be enclosed as required by OSHA standard 29 CFR 1910 to protect worker from accidental contact with the belts and sheaves.

H. Motor and Drives:

1. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have motors field installed by the contractor. The contractor shall be responsible for all costs associated with installation of motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.
2. Motors shall meet or exceed all NEMA Standards Publication MG 1 – 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
3. Fan Motors shall be heavy duty, NEMA Premium efficient operable at 480/60/3, exceeding the EPAct efficiency requirements.
4. Motors shall be 1800 rpm, except where noted, and shall NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads.
5. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.
6. V-Belt Drive shall be variable pitch rated at 1.5 times the motor nameplate. Drives 20 hp and larger or any drives on units equipped with VFDs shall be fixed pitch.
7. Drives shall have minimum horsepower ratings of 150% of motor horsepower and shall be of sufficient size to start and bring equipment up to speed without slipping or squealing. Drives for motors 1-1/2 HP and larger shall have minimum of two belts.
8. Sheaves shall be cast iron and dynamically balanced. Motor sheaves shall be adjustable pitch type, with wide range of adjustment, selected so that design fan speed is at midpoint of adjustment range. Sheaves for motor and fan shafts on drives of 3 HP and larger shall have bronze shaft bushings.
9. Multi-belt drives shall have matched sets of belts to ensure equal tension and equal wear on all belts.
10. Drives not enclosed within equipment cabinets or casings shall have belt guards, easily removable, supported to prevent rattling or other noise. Guard shall be fully enclosed type, with holes opposite all shafts, for checking speeds without removing guard.
11. For each belt drive, furnish spare set of belts, tagged with fan number.
12. Manufacturer shall provide for each fan a nameplate with the following information to assist air balance contractor in start up and service personnel in maintenance:
    a. Fan and motor sheave part number
    b. Fan and motor bushing part number
    c. Number of belts and belt part numbers
    d. Fan design RPM and motor HP
    e. Belt tension and deflection
    f. Center distance between shafts

I. Coils:

1. Coils section side panels shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

2. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
3. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
4. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
5. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.
6. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions.
7. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.
8. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
9. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
10. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
11. Headers shall be constructed of round copper pipe or cast iron.
12. Tubes shall be 1/2 inch O.D., minimum 0.025 inch thick copper. Fins shall be aluminum.

J. Filters:
1. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement.
2. Filter type, MERV rating shall be:
   a. MERV-8 pre-filters before any coil, group of coils, final filter, or energy recovery device.
   b. MERV-14 final filters.
3. Manufacturer shall provide one set of startup filters and one set of final filters for use upon substantial completion.

K. Dampers:
1. All dampers shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3

CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

L. Variable Frequency Drives (VFD's)
1. Variable frequency drives with bypasses shall be provided, mounted and wired by the AHU manufacturer as indicated on the schedule, sequence of operations or drawings. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. The VFDs shall be UL listed. VFD's shall be provided for each fan.

M. Ultraviolet (UVc) Lights
1. UV-C light fixtures and lamps shall be provided by the air handler manufacturer. The UV-C fixtures shall be factory-assembled and tested in the air handler. Lamp life shall be 9,000 hours minimum with no more than a 15% loss of output after one year of continuous use. The UV-C fixtures and lamps shall be accessible via downstream door for maintenance of the bulbs. Fixtures shall meet the UL drip-proof design criteria. Fixtures shall be constructed of UV resistant polymer to resist corrosion. Fixtures shall have been tested and recognized by UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards 153, 1598 & 1995.

N. Pipe Cabinets
1. External Pipe Cabinets
a. The AHU/DOA Manufacturer shall provide external pipe cabinet assemblies for all units. External pipe cabinets shall be factory assembled and shipped with the units for field mounting. Pipe cabinet walls shall be double wall construction. Cabinet interior and exterior walls panels shall be of the same construction as the unit interior and exterior wall panels, respectively. Cabinet interior ceiling and exterior roof panels shall be of the same construction as the unit interior ceiling and exterior roof panels, respectively. Cabinet roofs shall be sloped away from the unit for water drainage.
b. External pipe cabinets shall be provided with doors as indicated on the schedule and drawings. Doors shall be double wall construction. Interior and exterior cabinet door panels shall be of the same construction as the unit interior and exterior door panels, respectively.
c. Insulation that meets a minimum R-value matching the unit shall be provided throughout all external pipe cabinet assemblies, including pipe cabinet doors. Insulation shall be injected foam. Foam shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the wall, ceiling, and door cavities in all directions so that no voids exist and settling of insulation is prevented. Pipe cabinet assemblies shall comply with NFPA 90 A.

O. Controls
1. Unit shall ship without controllers and end devices as all will be supplied and field mounted by Automatic Temperature Controls Contractor.

P. Fixed plate heat exchanger (where noted on schedules) shall have the following features:

1. Air-to-air, fixed-plate heat exchangers shall be provided as indicated on the schedule and drawings. Exchangers shall be a cross flow, plate-type with no moving parts or secondary heat transfer surfaces. Plates shall be a minimum 99.5% aluminum and formed with a plate profile for maximum efficiency and cleanability, and minimizes pressure loss. The connecting plate edges shall be double-folded and internally sealed with a silicone free elastic resin to minimize leakage. The corners of assembled exchanger packages shall also be sealed to minimize leakage. The connecting plate edges shall be double-folded and internally sealed with a silicone free elastic resin to minimize leakage. The corners of assembled exchanger packages shall also be sealed to minimize leakage. Heat exchanger assemblies shall be able to withstand temperatures of 212.0 F. Access to all four faces of exchangers shall be provided for cleaning and inspection. Drain pans shall be provided under each the supply and exhaust sides of the exchanger, with drain connections extending to the exterior of the unit base. Drain pans shall be galvanized of the same construction as provided in other unit sections.
2. Heat exchangers shall meet the leaving air temperature (LAT) as shown on the schedule while operating at the specified conditions and while operating in frost prevention mode. Frost prevention systems shall provide continuous output temperatures. Defrost systems with temperature swings due to defrost cycles will not be acceptable. Frost systems shall incorporate a partial face damper factory installed on the outside air side of the exchanger.
3. The heat exchanger shall be certified to ANSI/AHRI Standard 1060 and bear the AHRI 1060 label. Performance characteristics of the heat exchanger shall be provided as defined by AHRI 1060 definitions. The heat exchangers EATR shall be less than 1% as shown by AHRI certification. Heat exchanger face velocity shall not exceed 500fpm and not exceed specified pressure drop. Performance shall match or exceed specified effectiveness. Condensate volume at design conditions shall be predicted by the air handling unit manufacturer.

PART 3 EXECUTION

3.1 FACTORY INSPECTIONS

A. All work shall be subject to the Owner's inspection and approval at all times, but such approval does not relieve the AHU Manufacturer of responsibility for proper functioning of material and work. Notification shall be given to the AHU Manufacturer by the Owner, in writing, a minimum of 10 business days in advance of the visit.

3.2 SHIPPING

A. Paper copies of the IOM shall also be shipped with each AHU.

B. The AHU Manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt of units when they are received. For parts too small to mark individually, the AHU Manufacturer shall place them in containers.

C. To protect equipment during shipment and delivery, all indoor and outdoor units shall be completely shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.

D. After loading the equipment for shipment, the AHU Manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

3.3 ON-SITE STORAGE

A. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

3.4 LEVELING

A. Contractor shall laser level all unit mounting surfaces, including housekeeping pads, roof curbs, and/or structural steel prior to rigging and installation of the AHU units. Should the AHU units be installed on an unlevel surface, Contractor shall rework the installation at his/her own expense and to the satisfaction of the Owner and Engineer and to ensure proper installation.

3.5 FIELD EXAMINATION

A. Contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.

B. Contractor shall verify that the proper power supply is available prior to starting of the fans.

3.6 INSTALLATION

A. Contractor shall be responsible to coordinate ALL of his installation requirements to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or -welded joints, and all other installation and assembly requirements.

B. The AHU Manufacturer shall provide all screws and gaskets for joining of sections in the field.

C. The AHU Manufacturer shall provide a factory-authorized service representative employed by the AHU Manufacturer to conduct a pre-installation inspection, provide rigging oversight, and supervise the AHU installation Contractor shall obtain site readiness approval from the AHU Manufacturer prior to proceeding with rigging and installation of AHU units.

D. Contractor shall verify that the following items have been completed prior to scheduling the AHU Manufacturer's final inspection and start-up:
   1. All spring-isolated components have had their shipping restraints removed and the components have been leveled.
   2. On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.
   3. All water piping connections have been completed and hydrostatically tested and all waterflow rates have been set in accordance with the capacities scheduled on the Drawings.

4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.
5. All power wiring, including motor starters and disconnects, serving the unit has been completed.
6. All automatic temperature and safety controls have been completed.
7. All dampers are fully operational.
8. All shipping materials have been removed.
9. All (clean) filter media has been installed in the units.

3.7 DEMONSTRATION

A. See Division 01 – General Requirements.

B. Demonstrate unit operation and maintenance.

C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.8 FINAL INSPECTION AND START-UP SERVICE

A. Factory-authorized service representative employed by the AHU Manufacturer shall inspect the installation. Contractor shall perform startup of the equipment.

B. The Building Management System (BMS) Contractor shall be scheduled to be at the job site at the time of the equipment start-up.

C. Under the guidance and supervision of the factory-authorized service representative Contractor, shall perform the following tests and services and submit a report outlining the results:
1. Record date, time, and person(s) performing service.
2. Lubricate all moving parts.
3. Check all motor and starter power lugs and tighten as required.
4. Verify all electrical power connections.
5. Conduct a start-up inspection per the AHU Manufacturer's recommendations.
6. Record fan motor voltage and amperage readings.
7. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.
8. Check fan for excessive vibration.
9. Check V-belt drive or coupling for proper alignment.
10. Check V-belt drive for proper tension. Tighten the belts in accordance with the AHU Manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the AHU Manufacturer.
11. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.
12. Disengage all shipping fasteners on vibration isolation equipment.
13. Check safety guards to ensure they are properly secured.
14. Secure all access doors to the fan, the unit and the ductwork.
15. Switch electrical supply "on" and allow fan to reach full speed.
16. Physically check each fan at start-up and shut-down to ensure no abnormal or problem conditions exist.
17. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.

18. Check all control sequences.

END OF SECTION

SECTION 238126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Indoor air handling unit.
2. Outdoor condensing unit.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades.
2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Vibration isolators.
3. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
4. Section 23 23 00 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.
5. Division 26: Electrical connection to units.

C. This project will be commissioned. Refer to Section 01 91 00 and Section 23 08 00 for commissioning information and responsibilities. The commissioning process will require additional labor, material, and/or other costs which must be provided by the work of the Division.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASTM International:
1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

D. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data indicating:
   1. Cooling and heating capacities.
   2. Dimensions.
   3. Weights.
   4. Rough-in connections and connection requirements.
   5. Duct connections.
   6. Electrical requirements with electrical characteristics and connection requirements.
   7. Controls.
   8. Accessories.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

E. Manufacturer’s Field Reports: Submit start-up report for each unit.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 77 00 - Closeout Procedures: Closeout procedures.

B. Project Record Documents: Record actual locations of controls installed remotely from units.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.5 QUALITY ASSURANCE

A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.

B. Cooling Capacity: Rate in accordance with ARI 210/240.

C. Sound Rating: Measure in accordance with ARI 270.

D. Insulation and adhesives: Meet requirements of NFPA 90A.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 31 00 – Project Management and Coordination: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 COORDINATION

A. Section 01 31 00 - Project Management and Coordination: Requirements for coordination.

B. Coordinate installation of condensing units with roof structure.

C. Coordinate installation of air handling units with building structure.

1.10 WARRANTY

A. Section 01 77 00 - Closeout Procedures: Requirements for warranties.

B. Manufacturer’s standard, no less than one year from date of Owner’s acceptance.

1.11 MAINTENANCE MATERIALS

A. Section 01 77 00 - Closeout Procedures: Requirements for maintenance materials.

B. Furnish one set of extra filters.

PART 2 PRODUCTS

2.1 SPLIT SYSTEM AIR CONDITIONING UNITS

A. Manufacturers:
1. Daikin.
2. Mitsubishi.
3. Samsung.

B. Product Description: Split system consisting of an indoor air handling unit and outdoor condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

2.2 AIR HANDLING UNIT

A. Configuration: As indicated on Drawings.

B. Cabinet:
   1. Panels: Constructed of galvanized steel with baked enamel finish. Access Panels: Located on both sides of unit. Furnish with duct collars on inlets and outlets.
   2. Insulation: Factory applied to each surface to insulate entire cabinet with one inch thick aluminum foil faced glass fiber with edges protected from erosion.

C. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with adjustable belt drive and high efficiency motor complying with NEMA MG1, Type 1. Motor permanently lubricated with built-in thermal overload protection.

D. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Factory leak tested under water. Removable, PVC construction, double-sloped drain pan with piping connections on both sides. Condensate evaporation trays are not permitted.

E. Refrigeration System: Single refrigeration circuits controlled by factory installed thermal expansion valve.

F. Air Filters: 2 inch 25 to 30 percent efficiency based on ASHRAE 52.1.

G. Air Handling Unit Accessories:
   1. Vibration Isolators: As specified in Section 23 05 48.

2.3 CONDENSING UNIT

A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.

C. Compressor: Single refrigeration circuit with rotary or semi-hermetic reciprocating type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection.

D. Condenser Coil: Constructed of copper tubing mechanically bonded to copper fins, factory leak and pressure tested.

E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.

F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.

G. Condensing Unit Accessories: Furnish the following accessories:
   1. Controls to provide low ambient cooling to 0 degrees F.
   2. Time delay relay.
   3. Anti-short cycle timer.

4. Disconnect switch.
5. Coil with corrosion resistant coating capable of withstanding salt spray test of 1000 hours in accordance with ASTM B117.
6. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
7. Suction and discharge pressure gauges.

H. Refrigeration specialties: Furnish the following:
1. Charge of compressor oil.
2. Holding charge of refrigerant.
3. Replaceable core type filter drier.
4. Liquid line sight glass and moisture indicator.
5. Shut-off valves on suction and liquid piping.
6. Liquid line solenoid valve.
7. Charging valve.
8. Oil level sight glass.
9. Crankcase heater.
10. Pressure relief device.

I. Refrigerant: Furnish charge of refrigerant R-410A.

2.4 CONTROLS

A. Furnish interface to Direct Digital Control System specified in Section 23 09 23.

2.5 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Refer to schedules on Construction Drawings.

B. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 31 00 - Project Management and Coordination: Verification of existing conditions before starting work.

B. Verify support for condensing unit is ready for unit installation.

3.2 INSTALLATION - AIR HANDLING UNIT

A. Install condensate piping with trap and route from drain pan to condensate drainage system. Refer to Section 23 21 13.

B. Install components furnished loose for field mounting.

C. Install connection to electrical power wiring in accordance with Division 26.

3.3 INSTALLATION - CONDENSING UNIT

A. Installation: Refer to Section 23 05 48.

B. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit. Refer to Section 23 23 00.

C. Evacuate refrigerant piping and install initial charge of refrigerant.

D. Install electrical devices furnished loose for field mounting.

E. Install control wiring between air handling unit, condensing unit, and field installed accessories.

F. Install connection to electrical power wiring in accordance with Division 26.

3.4 MANUFACTURER'S FIELD SERVICES

A. Section 23 04 00 – Heating, Ventilating and Air Conditioning: Requirements for manufacturer’s field services.

B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.5 CLEANING

A. Section 01 77 00 - Closeout Procedures: Requirements for cleaning.

B. Vacuum clean coils and inside of unit cabinet.

C. Install new throwaway filters in units at Substantial Completion.

3.6 DEMONSTRATION

A. Section 23 04 00 – Heating, Ventilating and Air Conditioning: Requirements for demonstration and training.

B. Demonstrate air handling unit operation and maintenance.

C. Demonstrate starting, maintenance, and operation of condensing unit including low ambient temperature operation.

D. Furnish services of manufacturer's technical representative to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 77 00 - Closeout Procedures: Requirements for protecting finished Work.

B. Do not operate air handling units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 238200

HYDRONIC HEATING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Duct mounted hot water coils.
2. Fin tube radiation.
3. Cabinet unit heaters.
4. Unit heaters.
5. Radiant ceiling panels
6. Panel radiators.
7. Air Curtains

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
3. Section 23 07 00 - HVAC Insulation: Execution requirements for insulation specified by this section.
4. Section 23 21 13 - Hydronic Piping: Execution requirements for connection of chilled water, hot water, and drain piping to units specified by this section.
5. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
6. Section 23 31 00 - HVAC Ducts and Casings: Execution requirements for ducts specified by this section.
7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connection to units specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

B. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers.

C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.

D. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access to valves.

C. Operation and Maintenance Data: Submit manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept units on site in factory packing. Inspect for damage. Store under roof.

C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 DUCT MOUNTED HOT WATER COILS

A. Manufacturers:
1. US Coil and Air

2. Trane
3. Daikin.
4. Johnson Controls.

B. Casing:
1. Die formed channel frame of 18 gage galvanized steel with 3/8 inch mounting holes on 3 inch centers.
2. Furnish intermediate center tube supports for plate fin coils longer than 36 inches. Furnish intermediate tube supports for spiral fin coils at manufacturer's recommended intervals to eliminate sagging during operation.

C. Water Coils:
1. Headers: Cast iron with tubes expanded into header, seamless copper tube with silver brazed joints, or prime coated steel pipe with brazed joints.
2. Tubes: 5/8 inch OD seamless copper or brass arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
3. Fins: Aluminum continuous plate type with full fin collars or individual helical Leak Testing: Air test under water to 200 psig for working pressure of 200 psig and 200 degrees F.
4. Configuration: Self draining circuitry, with threaded plugs in headers for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes. Furnish threaded plugs in return bends or in headers opposite top and bottom of each tube.

2.2 FIN TUBE RADIATION

A. Manufacturers:
1. Modine
2. Vulcan
3. Slant Fin
4. Sterling
5. Rittling.

B. Heating Elements: Seamless copper tubing, mechanically expanded into evenly spaced aluminum fins, suitable for soldered fittings.

C. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

D. Enclosures: 0.0478 inch thick steel up to 18 inches in height, 0.598 inch steel over 18 inches in height, with easily jointed components for wall to wall installation. Support rigidly, on wall or floor mounted brackets at least 3 feet on center maximum.

E. Finish: Factory applied baked enamel of color as selected.

F. Damper: Where heating media is not thermostatically controlled, furnish knob-operated internal damper at enclosure air outlet.

G. Access Doors: For otherwise inaccessible valves, furnish factory-made permanently hinged access doors, 6 x 7 inch minimum size, integral with cabinet.

2.3 CABINET UNIT HEATERS

A. Manufacturers:
1. Modine
2. Vulcan
3. Sterling
4. Rittling

B. Coils: Seamless copper tubing with evenly spaced aluminum fins mechanically bonded to tubing. Coils shall be leak tested to minimum 200 psig, air under water.

C. Front panel: 16 gage steel with sound dampening insulation and tamper resistant locks.

D. Finish: Factory applied baked enamel finish.

E. Fans: Direct-drive, centrifugal, statically and dynamically balanced.

F. Access area: Open area at each end of cabinet for electrical wiring and piping accessories. Provide with access door.

G. Accessories: Provide permanent aluminum filter. For wall mounted unit, provide wall gasketing seal for recessed units. For floor mounted units, provide leveling legs for non recessed units.

2.4 UNIT HEATERS

A. Manufacturers:
1. Modein
2. Vulcan
3. Sterling
4. Rittling

B. Coils: Seamless copper tubing, 0.025 inch minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

C. Casing: 0.0478-inch thick steel with threaded pipe connections for hanger rods.

D. Finish: Factory applied baked enamel of color as selected.

E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

F. Air Outlet: Adjustable pattern diffuser on projection models and two four-way louvers on horizontal throw models.

G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Section 23 05 13.

H. Control: Local multi-speed disconnect switch.

2.5 RADIANT CEILING PANELS

A. Manufacturers:
1. Sterling
2. TWA
3. Airtex
4. Airtite

B. Panel Construction:
1. Extrusion panel thickness approximately 0.100".
2. Panel tube: 0.500" I.D. copper.
3. Panels have "U" shaped channel on the back of the extrusion into which the copper tube is inserted. The "U" shaped channel is then formed more than half way around the copper tube for increased thermal conduction and to eliminate any separation of the copper and the aluminum strip.
4. Panels are made of multiple extrusions. Refer to schedules for arrangements.
   a. Units shall be factory assembled.
   b. Return bends shall be factory installed.
   c. Cross bar to maintain flatness and provide anchor point for panel suspension shall be provided.
   d. Apply two coats baked enamel paint only to the finished side of panels after assembly of color as selected by the architect.
   e. Maximum panel length shall be12 feet. Units shall run wall to wall and shall be field measured prior to manufacturing. Where specified length of a panel exceeds the maximum panel length, divide the required length into equal length sections. The use of "filler sections" is not acceptable.
   f. Face configuration: V-groove.
5. Interconnecting tube:
   a. Type "L" copper 3/8" (0.500 O.D.), to type "M" hard copper 1/2" nominal (0.625 O.D.) 0.028" wall thickness.
   b. Solder 95/5 tin antimony.
6. Insulation:
   a. Fiberglass: 3/4 pound per cubic foot density.
   b. Thickness: 2" nominal.
7. Suspension Wire:
   a. Galvanized, soft-annealed steel wire, 12 gauge.
   b. Spacing not to exceed four feet on center.

2.6 AIR CURTAINS

A. Manufacturers:
1. XXX

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. For recessed units, verify recess dimensions are correct size.

C. Verify wall construction is ready for installation.

D. Verify ductwork is ready for installation.

E. Verify concealed blocking and supports are in place and connections are correctly located.

3.2 INSTALLATION

A. Install air coils in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible. Refer to Section 23 31 00.

B. Duct Mounted Coils: Support air coil sections independent of piping on steel channel or double angle frames and secure to casings. Furnish frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Install with airtight seal between coil and duct or casing.

C. Supports for Hung Equipment including duct mounted coils, unit heaters, cabinet unit hears and radiant ceiling panels: Provide vibration isolation and seismic supports per Specification Section 23 0548. Support equipment independent of piping.

D. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

E. Install coils level. Install cleanable tube fluid coils and level frame steam coils with 1: 50 pitch.

F. Make connections to coils with unions and flanges.

G. On water coils, install shut-off valve on supply piping and lockshield balancing valve on return piping. Locate water supply at bottom of supply header and return water connection at top. Install manual float operated automatic air vents at high points complete with stop valve. Install water coils to be drainable and install drain connection at low points. Refer to Section 23 21 13.

H. On water and glycol heating coils, connect water supply piping to leaving airside of coil (counter flow arrangement). Refer to Section 23 21 13.

I. Install insulation air coil casings. Refer to Section 23 07 00.

J. Insulate headers located outside airflow, insulate as specified for piping. Refer to Section 23 07 00.

K. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.

L. Protection: Install finished cabinet units with protective covers during remainder of construction.

M. Radiation: Install cover/enclosures wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Install end enclosure pieces at end of each section. All piping shall be enclosed.

N. Cabinet Unit Heaters: Install at locations as indicated on Drawings. Coordinate to assure correct recess size for recessed convectors.

O. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

P. Hydronic Units: Install with shut-off valve on supply piping and lockshield balancing valve on return piping. Where not accessible, extend vent to exterior surface of cabinet for servicing. For cabinet unit heaters, fan coil units, and unit heaters, install float operated automatic air vents with stop valve. Refer to Section 23 21 13.

3.3 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

D. Install new filters.

END OF SECTION

SECTION 260400

GENERAL CONDITIONS FOR ELECTRICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This section applies to certain sections of Division 08 “Openings”, Division 11 “Equipment”, Division 12 “Furnishings”, Division 21“Fire Protection, Division 22 “Plumbing”, Division 23 "Mechanical," Division 27 “Communications”, Division 28 “Electronic Safety and Security”, Division 33 “Utilities” and this section applies to all sections of Division 26, "Electrical" of this project specification unless specified otherwise in the individual sections.

C. The Drawings of other trades Architectural, Structural, Landscape, Civil, Mechanical, Fire Protection and Plumbing, Communications, and Electronic Safety and Security shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

D. The drawings of equipment suppliers shall be examined for coordination and familiarity of work with Owner’s equipment suppliers.

1.2 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division, (Division 27 and Division 28). Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

C. It is the intent of this Section of the Specifications to establish a standard of quality and performance characteristics for basic materials and installation methods used in building electrical (communications and electronic safety and security) systems.

1.3 INTENT

A. This contract is for all labor, materials and equipment required for installation. The system shall be complete and finished in all respects, tested and ready for operation. Work shall

include calibration of equipment with factory settings. All materials, equipment and apparatus shall be new and of first class quality.

B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.

C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.

D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

E. Location of all existing systems and equipment shown on floor plans is based on the best available information. The Contractor shall verify all dimensions and locations of existing systems and equipment in the field and adjust as necessary.

F. Certain items of existing equipment may be indicated for removal or relocation. Items noted for removal shall be disconnected and turned over to the Owner or disposed of by the Contractor if the Owner so requests. If instructed to dispose of items, the Contractor shall remove the items from the premises and dispose of them in a safe, legal and responsible manner and location. Items noted for relocation are intended for reuse in another location as designated on the Drawings. It shall be the responsibility of the Contractor to remove the material from its present location, store the material in a safe place and reinstall the material in its new location. Questions regarding the suitability of the material or equipment shall be brought to the attention of the Owner and Engineer in writing.

G. Wherever a particular piece of equipment, device or material is specifically indicated on the Drawings by model number, type, series or other means, that specification shall take precedence over equipment or materials specified herein. For example: If a particular switch is specified on the Drawings, its specification takes precedence over switch specified herein.

1.4 DEFINITIONS

A. Word “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.

B. Word “install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.

C. Words “furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, all ready to be installed including where appropriate all necessary interim storage and protection.

D. Word “provide” shall mean furnish (or supply) and install as necessary.

E. Word “finished” refers to all rooms and areas scheduled to be painted in Room Finish Schedule on the drawings. All rooms and areas not covered in Schedule, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

F. No Exceptions Taken – reviewed and determined to be in general conformance with contract documents.

G. Words “approved equal” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

H. Word “wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

I. Word “product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

J. Substitutions: Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the Contractor after award of the Contract are considered requests for "substitutions."

K. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled” and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

L. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

M. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.

N. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

O. Remove: The term “remove” means “to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”

P. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

Q. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades, furniture layouts and/or for proper execution of the work.

D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, higher rating, or higher value shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.6 SURVEYS AND MEASUREMENTS

A. Before submitting his Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which his work will be installed. This Contract includes all modifications of existing systems required for the installation of new equipment. This Contract includes all necessary offsets, transitions and modifications required to install all new equipment in existing spaces. All new and existing equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions he makes, any omissions or errors he makes as a result of his failure to become fully familiar with the existing conditions at the site and the Contract Documents.

B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

1.7 CODES AND STANDARDS

A. Reference Standard Compliance

1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
2. Independent Testing Organization Certificate: In lieu of the label or listing, indicated above submit a certificate from an independent testing organization, competent to perform testing, and approved by the engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

B. The Following Codes and Standards for the state and local jurisdiction where the project is located as listed below apply to all electrical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
The International Building Code

The International Mechanical Code

The International Plumbing Code

NFPA 70, the National Electrical Code

NFPA 101, Life Safety Code

NECA - 1 Standard for Good Workmanship in Electrical Construction

ASHRAE 90.1 and International Energy Conservation Code

C. The following Standards shall be used where referenced by the following abbreviations:

AIA	American Institute of Architects
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
IEEE	Institute of Electrical and Electronics Engineers
NBS	National Bureau of Standards
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSC	National Safety Council

OSHA Occupational Safety and Health Administration

UL Underwriters' Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.8 PERMITS AND FEES

A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.9 EQUIPMENT EQUIVALENTS AND SUBSTITUTIONS

A. Certain manufacturers of material, apparatus or appliances are indicated in the drawings and specifications for this project. These items have been used as the basis of design, and as a convenience in fixing the minimum standard of workmanship, finish and design that is required. If the Contractors uses an "approved equal" alternative to the basis of design, and if the features of that alternative have an impact on other components of the Project, the Contractor shall include the necessary adjustments in those components, whether for architectural, structural, mechanical, electrical, fire protection, or any other elements, plus any adjustments for difference in performance.

B. Where one name only is used and is followed by the words "or approved equal", the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.

C. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for Architect and Engineer review.

D. Where the Contractor proposes to use an item that is different from the basis of design in the Drawings and specifications, and that will require the redesign of the structure, partitions, foundations, piping, wiring or any other component of the mechanical, electrical, or architectural layout, the Contractor shall provide the necessary redesign of those components.

E. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the basis of design scheduled equipment or materials as hereinafter specified or shown on the drawings, they are required to submit a request for substitution in writing. The Contractor shall state in their request whether it is a substitution,

equivalent or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer's equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

F. If an alternative or substitute item results in a difference in quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit, and equipment from that specified or indicated on the Drawings, the Contractor shall furnish and install any such additional equipment required by the system, at no additional cost to the Owner including any costs added to other trades due to the equivalent change from the basis of design detailed in the drawings or included within the specifications.

G. Equipment, material or devices submitted for review as an "equivalent" shall meet the following requirements:
   1. The equivalent shall have the same construction features such as, but not limited to:
      a. Material thickness, gauge, weight, density, etc.
      b. Welded, riveted, bolted, etc., construction
      c. Finish, undercoating, corrosion protection
   2. The equivalent shall perform with the same or better operating efficiency.
   3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
   4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.

H. Equipment, material or devices submitted for review as a "substitution" shall meet the following requirements:
   1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
   2. Submit three (3) copies of each request for substitution for consideration.
   3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
      a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
      b. Samples, where applicable or requested.
      c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
      d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
      e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the

substitution. Indicate the effect of the proposed substitution on overall Contract Time.

f. Cost information, including a proposal of the net change, if any in the Contract Sum.

g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.

h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.

i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.

1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.

2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.10 SUBMITTAL PROCEDURES

A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
   1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
   2. If an intermediate submittal is necessary, process the same as the initial submittal.
   3. Allow two weeks for reprocessing each submittal.
   4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
   1. Include the following information on the label for processing and recording action taken.
      a. Project name.
      b. Date.
      c. Name and address of Engineer.
      d. Name and address of Contractor.
      e. Name and address of subcontractor.
      f. Name and address of supplier.
      g. Name of manufacturer.
      h. Number and title of appropriate Specification Section.
      i. Drawing number and detail references, as appropriate.

E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

F. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.

G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

H. LEED Submittals: Provide manufacturers' or third-party certification of testing to and compliance with the California Department of Public Health (CDPH) Standard method v1.2-2017, that includes the following information:
   1. The exposure scenario used to determine compliance.
   2. The range of total VOCs after 14 days, measured as specified in the CDPH Standard Method v1.2:
   3. 0.5 mg/m^3 or less;

4. Between 0.5 and 5.0 mg/m^3; or
5. 5.0 mg/m^3 or more
6. Laboratory accreditation under ISO/IEC 17025.
7. Claims of compliance for wet-applied products must state the amount applied in mass per surface area
8. Provide MSDS or other manufacturer documentation with disclosure of VOC content for all wet-applied products.
9. Complete "LEED Materials Documentation Sheet" with IEQc2 information for adhesives/sealants installed within the waterproofing membrane.

1.11 SHOP DRAWINGS

A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Electrical Contract. Refer to the General Conditions and Supplementary General Conditions for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.

C. Provide shop drawings for all devices specified under equipment specifications for all systems including fire alarm, switchgear, clock, lighting, etc., or where called for elsewhere in the Specifications, or where scheduled on the drawings, or where called out on the drawings. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures) of all shop drawings, performance cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

D. Submittals shall be marked with the trade involved, i.e., Electrical, HVAC, Plumbing, Fire Protection, etc. when the submittal could involve more than one trade.

E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

F. Failure to submit shop drawings in ample time for review shall not entitle the Contractor to an extension of Contract time. No claim for extension by reason of such default will be

allowed, nor shall the Contractor be entitled to purchase, furnish and/or install equipment which has not been reviewed by the Engineer.

G. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.

H. Acceptance rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.

I. Acceptance of shop drawings shall not apply to quantity nor relieve Contractor of his responsibility to comply with intent of Drawings and Specifications.

J. Acceptance of shop drawings is final and no further changes will be allowed without the written consent of the Engineer.

K. Acceptance of shop drawings does not relieve the Contractor from submitting, coordinating and implementing schedules, forms, worksheets and similar as required for owner/operator input and approval as specified herein and required for proper system operation.

L. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.

M. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.

N. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

1.12 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 01 Section "PROJECT COORDINATION," to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. Indicate the proposed locations of light fixtures, panelboards, conduits, cabinets, etc. Include the following:
   2. Clearances for installing and maintaining insulation.
   3. Clearances for servicing and maintaining equipment, including NEC requirements and space for equipment disassembly required for periodic maintenance.
   4. Equipment connections and support details.

5. Exterior wall and foundation penetrations.
6. Fire-rated wall and floor penetrations.
7. Sizes and locations of required concrete pads and bases.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

E. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. If the Contractor elects to obtain the Engineers electronic files an Electronic File Release Form must be submitted. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic File Release Form, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the Electronic File Release Form is appended to the end of this specification section

1.13 COORDINATION WITH OTHER DIVISIONS

A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.

B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, heating, condenser, chilled water piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.

C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.

D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

E. Where work is installed prior to preparation and approval of the Coordination Drawings or in conflict with the approved Coordination drawings and if so directed in other Sections, the Contractor indicated shall prepare composite working drawings and sections clearly

showing how the work is to be installed in relation to the work of other trades, at no extra charge to the Owner.

1.14 WORKMANSHIP

A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, journeymen, electricians, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

E. All labor for installation of electrical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.15 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.

B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.16 TEMPORARY UTILITIES

A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. First Aid Supplies: Comply with governing regulations.

D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.

E. Provide temporary lighting in all areas, throughout construction activities.
   1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
   2. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.
      a. Except where overhead service must be used, install electric power service underground.
      b. Power Distribution System: Install wiring overhead, and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, AC 20 ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.
   3. Temporary Telephones: Provide temporary telephone service for all personnel engaged in construction activities, throughout the construction period.

F. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

G. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.17 PROJECT PHASING

A. Work under each Section shall include all necessary temporary connections, equipment, conduit, wiring, fire alarm equipment and testing, lighting and emergency lighting, fire

stopping, connection of necessary mechanical equipment, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner.

1.18 PROTECTION OF MATERIALS AND EQUIPMENT

A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.

B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.19 ADJUSTING AND TESTING

A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.

B. Where requested by the Engineer or specified in the contract documents, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct the personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing that the equipment was installed according to manufacturer’s recommendations and is operating as intended by the manufacturer. Factory start-up reports shall be included in the operation and maintenance manuals under the appropriate equipment section.

1.20 CLEANING

A. The Contractor shall thoroughly clean all equipment of all foreign substances, oils, dust, dirt, etc., inside and out before final acceptance by the Engineer.

B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the

course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

C. During the course of construction, all conduits shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.

D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work.

E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
1. Remove labels that are not permanent labels.
2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces and panelboard interiors.
4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean light fixtures and lamps.

F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.

G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.21 OPERATING AND MAINTENANCE

A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner’s representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) day notice to the Owner and the Engineer in advance of this period.

B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

D. An authorized manufacturer’s representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. At a minimum, the following equipment will require this inspection: emergency generator, fire alarm system,

nurse call system, paging systems, etc. These letters will be bound into the operating and maintenance books.

E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

F. Demonstration shall be recorded on electronic media with two (2) copies turned over to the Owner.

1.22 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty, 3-ring, vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.

B. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Emergency instructions.
6. Spare parts list.
7. Copies of warranties.
8. Wiring diagrams.
9. Recommended "turn around" cycles.
10. Inspection procedures.
11. Shop Drawings and Product Data.
12. Equipment start-up reports.

C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.

D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

E. LEED Requirements:
1. For field applications that are inside the weatherproofing membrane: Adhesives/sealants must be tested and determined compliant in accordance with

California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario. The default scenario is the private office scenario.

2. All adhesives/sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.

1.23 ACCEPTANCES

A. The equipment, materials, workmanship, design and arrangement of all work installed under the Electrical Sections shall be subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, the Electrical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Electrical Sections. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.

C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of the awarding of the Contract. In such instances, deviations may be made pending acceptance by the Engineer or the Owner’s representative.

D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Electrical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.

F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.24 RECORD DRAWINGS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark

whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
2. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
3. Note related Change Order numbers where applicable.
4. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
5. Final record documents shall be prepared in the latest AutoCad or Revit version and digital media for all drawings and a clean set of reproducible paper copies shall be turned over to the Owner at the completion of the work.

1.25 WARRANTIES AND BONDS

A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
   1. General close-out requirements included in Section "Project Close-out."
   2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions 02 through [50].
   3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.26 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding

defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
   1. Refer to individual Sections of Divisions 2 through [16][50] for specific content requirements, and particular requirements for submittal of special warranties.

J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
   1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
   2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.

3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.27 GUARANTEES

A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineers satisfaction.

B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided

1.28 PROJECT CLOSE-OUT

A. Contractor shall submit annual maintenance proposal to the Architect/Engineer for review and approval as part of the close out documents.

B. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.

C. Deliver tools, spare parts, extra stock, and similar items.

D. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

E. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

F. Inspection Procedures: On receipt of a request for inspection, the Engineer will either proceed with inspection or advise the Contractor of unfilled requirements. The Engineer will prepare the Certificate of Substantial Completion following inspection, or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
1. The Engineer will repeat inspection when requested and assured that the Work has been substantially completed.
2. Results of the completed inspection will form the basis of requirements for final acceptance.

END OF SECTION

Electronic File Release Form

DELIVERY OF ELECTRONIC FILES FOR: _____

Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ _____

Client's Signature Date

_____

Company - Title

_____ _____

Architects' Signature Date

_____

Firm - Title

_____ _____

Owner's Signature Date

_____

Company - Title

SECTION 260503

EQUIPMENT WIRING CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes electrical connections to equipment.

B. Related Sections:
1. Section 26 05 19 – Building Wire and Cable.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 27 26 – Wiring Devices.
4. Section 26 28 13 – Fuses.
5. Section 26 28 19 - Enclosed Switches.
6. Section 26 29 13 – Enclosed Controllers.

C. Related Requirements:
1. This section applies to certain sections of Division 8 “Door Hardware”, Division 11 “Equipment”, Division 12 “Furnishings”, Division 21 “Fire Protection”, Division 22 “Plumbing”, Division 23, "Mechanical,", Division 27 “Communications”, and Division 28 “Electronic Safety and Security” of this project specification unless specified otherwise in the individual sections.
2. The Drawings of other trades (Architectural, Plumbing, Mechanical, Equipment, Fire Protection, Communications, and Electronic Safety and Security) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Submittal procedures.

B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.5 COORDINATION

A. Division 01 - General Requirements.

B. Obtain and review equipment schedules and specifications for equipment furnished under other sections and by the Owner.

C. Obtain and review shop drawings, product data, manufacturer’s wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

D. Determine connection locations and requirements, including requirements for enclosed switches, enclosed controllers, variable frequency drives, control stations, safety devices, control wiring, and accessories for equipment furnished under other sections and by the owner.

E. Sequence rough-in of electrical connections to coordinate with installation of equipment. Do not proceed with rough-in without coordination of requirements for equipment furnished under other sections or by the owner.

F. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 CORD AND PLUGS

A. Manufacturers:
1. Hubbell.
2. Leviton.
3. Bryant.
4. Substitutions: Section 01 60 00 - Product Requirements

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.

D. Cord Construction: Type SO, SJO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 - General Requirements.

B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.2 INSTALLATION

A. Make electrical connections.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Install receptacle outlet to accommodate connection with attachment plug.

E. Install cord and cap for field-supplied attachment plug.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes, buss plugs and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, safety devices and control devices to complete equipment wiring requirements.

H. Install fuses, fuse holders and terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

J. Install conduit and wiring for interconnection of motorized door operator and motorized fire door control stations, safety devices and accessories to complete equipment wiring requirements.

K. Install conduit and wiring for interconnection of specialty equipment (ex. motorized divider partitions, scoreboards, motorized backboards, shot clock) control stations, safety devices and accessories to complete equipment wiring requirements.

L. Install conduit and wiring for interconnection of receptacles, lighting and switches furnished with equipment.

M. Install conduit and wiring for interconnection of alarm initiating devices, control panels and annunciators furnished with equipment.

N. Install conduit and wiring for interconnection of power supplies furnished by other divisions.

3.3 ADJUSTING

A. Division 01 - General Requirements.

B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION

SECTION 260519

BUILDING WIRE AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single conductor building wire.

B. Underground feeder and branch-circuit cable.

C. Metal-clad cable.

D. Power and control tray cable.

E. Wiring connectors.

F. Electrical tape.

G. Heat shrink tubing.

H. Oxide inhibiting compound.

I. Wire pulling lubricant.

J. Cable ties.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Division 07.–Thermal and Moisture Protection.

C. Section 26 0400 – General Conditions for Electrical Trades

D. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

F. Section 28 3100 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.3 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005 (Reapproved 2015).

E. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation; 2016.

F. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.

G. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.

H. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation); Federal Specification; Revision A, 2008.

I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

J. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable; 2012.

K. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.

L. NECA 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF); 2007.

M. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.

N. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.

O. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

Q. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

R. UL 183 - Manufactured Wiring Systems; Current Edition, Including All Revisions.

S. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

T. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

U. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

V. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables; Current Edition, Including All Revisions.

W. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

X. UL 719 - Nonmetallic-Sheathed Cables; Current Edition, Including All Revisions.

Y. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the installation of direct burial cable with other trades to avoid conflicts with piping or other potential conflicts.
3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Division 01 – General Requirements.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.

D. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures to accommodate substituted conductors.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 – General Requirements.
2. Extra Manufactured Wiring Systems Cable Assemblies: One of each configuration, 6 feet (2000 mm) length.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated and permitted.

C. Nonmetallic-sheathed cable is not permitted, unless noted otherwise.

D. Service entrance cable is not permitted, unless noted otherwise.

E. Armored cable is not permitted.

F. Mineral Insulated Cable permitted as follows:
1. Rated Feeders requiring a 2-hour protective rating.
2. Fire Alarm and Control Circuits requiring survivability rating.

G. Metal-clad cable is permitted as follows:
1. Use above accessible ceilings and routed in hollow walls:
   a. For branch circuit wiring within each room after first junction box, homeruns shall be installed in EMT or other raceway as indicated in Section 26 05 33. Branch circuit extensions between rooms shall be installed in EMT or other raceway as indicated in Section 26 05 33.
   b. For final connections to interior equipment (6 ft. length maximum) above ceilings.
   c. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
      1) Maximum Length: 6 feet.
2. In addition to other applicable restrictions, may not be used for:
   a. Life Safety.

b. Homeruns from first device, such as lighting fixture, MEP equipment, wiring device to panelboards.
c. Where not approved for use by the authority having jurisdiction.
d. Where exposed to view.
e. Where exposed to damage.
f. For damp, wet, or corrosive locations.
g. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.
h. For patient care areas of health care facilities requiring redundant grounding, unless using HCFC Type cable.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Provide conductors and cables with lead content less than 300 parts per million.

D. Provide new conductors and cables manufactured not more than one year prior to installation.

E. Unless specifically indicated to be excluded, provide all conduit, boxes, wiring and connectors for a complete operating system.

F. Comply with NEMA WC 70.

G. Comply with FS A-A-59544 where applicable.

H. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

I. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

J. Conductors for Grounding and Bonding: Also comply with Section 26 0526.

K. Conductors and Cables Installed in Cable Tray: Listed and labeled as suitable for cable tray use.

L. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.

M. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.

N. Conductor Material:
1. Provide copper conductors except where aluminum conductors are specifically indicated or permitted for substitution. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.

a. Substitution of aluminum conductors for copper is permitted, when approved by Engineer, Owner and authority having jurisdiction, only for the following:
   1) Services: Copper conductors size 1/0 AWG and larger.
   2) Feeders: Copper conductors size 1/0 AWG and larger.
b. Where aluminum conductors are substituted for copper, comply with the following:
   1) Size aluminum conductors to provide, when compared to copper sizes indicated, equivalent or greater ampacity and equivalent or less voltage drop.
   2) Increase size of raceways, boxes, wiring gutters, enclosures to accommodate aluminum conductors.
   3) Provide aluminum equipment grounding conductor sized according to NFPA 70.
   4) Equip electrical distribution equipment with compression lugs for terminating aluminum conductors.

2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, or ASTM B8unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.
4. Aluminum Conductors (only where specifically indicated): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.

O. Minimum Conductor Size:
1. Branch Circuits: 12 AWG.
   a. Exceptions:
      1) 20 A, 120 V circuits longer than 75 feet 10 AWG minimum, and sized for voltage drop.
      2) 20 A, 120 V circuits longer than 150 feet 8 AWG minimum, and sized for voltage drop.
      3) 20 A, 277 V circuits longer than 150 feet: 10 AWG minimum, and sized for voltage drop.
2. Control Circuits: 14 AWG.

P. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

Q. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise directed by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
   a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
3. Color Code:
   a. 480Y/277 V, 3 Phase, 4 Wire System:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
      4) Neutral/Grounded: Gray.
   b. 208Y/120 V, 3 Phase, 4 Wire System:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
      4) Neutral/Grounded: White.

c. 240/120 V High-Leg Delta, 3 Phase, 4 Wire System:
   1) Phase A: Black.
   2) Phase B (High-Leg): Orange.
   3) Phase C: Blue.
   4) Neutral/Grounded: White.
d. 240/120 V, 1 Phase, 3 Wire System:
   1) Phase A: Black.
   2) Phase B: Red.
   3) Neutral/Grounded: White.
e. Equipment Ground, All Systems: Green.
f. Isolated Ground, All Systems: Green with yellow stripe.
g. Travelers for 3-Way and 4-Way Switching: Pink.
h. For control circuits, comply with manufacturer's recommended color code.

2.3 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:
   1. Copper Building Wire:
      a. Cerro Wire LLC.
      b. Southwire Company
      c. General Cable Technologies
      d. Substitutions: See Section 01 - Product Requirements.
   2. Aluminum Building Wire (only where specifically indicated):
      a. Encore Wire Corporation
      b. Southwire Company
      c. Stabiloy, a brand of General Cable Technologies Corporation
      d. Substitutions: See Section 01 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:
   1. Feeders and Branch Circuits:
      a. Size 10 AWG and Smaller: Solid.
      b. Size 8 AWG and Larger: Stranded.
   2. Control Circuits: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:
   1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
      a. Installed Underground: Type XHHW-2.
   2. Aluminum Building Wire (only where specifically indicated): Type XHHW-2.
   3. Isolated Power Systems (operating room panel wiring): Type XHHW-2 rated VW-1 conductors with cross-linked polyethylene (XLP) insulation in conduit.

2.4 UNDERGROUND FEEDER AND BRANCH-CIRCUIT CABLE

A. Manufacturers:
   1. Cerro Wire LLC.
   2. Encore Wire Corporation.
   3. Southwire Company.
   4. General Cable Technologies.
   5. Substitutions: See Section 01 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Provide equipment grounding conductor unless otherwise indicated.

D. Conductor Stranding:
1. Size 10 AWG and Smaller: Solid.
2. Size 8 AWG and Larger: Stranded.

E. Insulation Voltage Rating: 600 V.

F. Insulation: Type XHHW-2.

2.5 METAL-CLAD CABLE

A. Manufacturers:
1. AFC Cable Systems Inc.
2. Encore Wire Corporation
3. Southwire Company
4. General Cable Technologies
5. Substitutions: See Section 01 - Product Requirements.

B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:
1. Size 10 AWG and Smaller: Solid.
2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Provide oversized neutral conductors where indicated or necessary.

G. Provide dedicated neutral conductor for each phase conductor.

H. Grounding: Full-size integral equipment grounding conductor.
1. Provide additional isolated/insulated grounding conductor where indicated or necessary.

I. Armor: Steel, interlocked tape.

J. Provide PVC jacket applied over cable armor where indicated for environment of installed location.

2.6 METAL CLAD CABLE (HCF)

A. Manufacturers:
1. AFC Cable Systems, Inc.
2. General Cable Co.
3. SouthWire.
4. Substitutions: See Division 01 – General Requirements.

B. Conductor: Copper.

C. Hospital Care Facility MC cable with redundant interlocking armor/bare aluminum bonding conductor in addition to green insulated grounding conductor. Color coded exterior jacket for identification as HCF cable.

D. Use: Use for final connections to recessed internal equipment or to fish within drywall partitions in the Health Services Exam rooms. (all other circuits shall be in EMT or other raceway as indicated within Section 26 05 33).

2.7 MINERAL INSULATED CABLE (TYPE M.I.)

A. Rating: M.I. cables shall be U.L. Listed and rated for 2 hours fire resistivity.

B. Handling: Cables shall be installed, stored, prepared, and terminated per manufacturer's requirements.

C. Splices: Splices shall be performed by manufacturer's representative or certified personnel trained in proper termination techniques.

D. Supports: Provide cable supports at 3'-0" max. horizontally, 6'-0" max. vertically. Anchors shall be steel.

E. Configuration: Single conductors run together to form multi-phase feeders shall be installed in a tri-foil configuration. All sheaths shall maintain contact with each other until entering into termination enclosure. Provide stainless steel straps to form bundles. Straps shall be installed at 3'-0" max. horizontal and vertical runs.

F. Sheath material: Seamless soft-drawn copper.

G. Lugs: Cables shall terminate on approved lugs.

H. Manufacturers: Pyrotenax/Pentair.

2.8 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 0526.

C. Wiring Connectors for Splices and Taps:
1. Copper conductors 10 AWG and smaller: Install insulated spring wire connectors with plastic caps
2. Copper Conductors Size 8 AWG: Install solderless pressure connectors with insulating covers
3. Copper Conductors Size 6 AWG and larger: Install pressure connectors or split bolt connectors.
4. Connectors for Aluminum Conductors: Use compression connectors.

D. Wiring Connectors for Terminations:
1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.

3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors.
6. Aluminum Conductors: Use compression connectors for all connections.
7. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
8. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
   a. 3M
   b. Ideal Industries, Inc.
   c. NSI Industries LLC.
   d. Ilsco
   e. Erico
   f. Substitutions: See Division 01 – General Requirements.

H. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
   a. Burndy LLC.
   b. Ilsco
   c. Thomas & Betts Corporation
   d. Substitutions: See Division 01 – General Requirements.

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
   a. Burndy LLC.
   b. Ilsco
   c. Thomas & Betts Corporation
   d. Erico
   e. Substitutions: See Division 01 – General Requirements.

J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:
   a. Burndy LLC.
   b. Ilsco
   c. Thomas & Betts Corporation
   d. Substitutions: See Division 01 – General Requirements.

2.9 WIRING ACCESSORIES

A. Electrical Tape:
   1. Manufacturers:
      a. 3M
      b. Plymouth Rubber Europa
      c. Substitutions: See Division 01 – General Requirements.
   2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F .
   3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
   4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
   1. Manufacturers:
      a. 3M
      b. Burndy LLC.
      c. Thomas & Betts Corporation
      d. Substitutions: See Division 01 – General Requirements.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
   1. Manufacturers:
      a. Burndy LLC.
      b. Ideal Industries, Inc.
      c. Ilsco
      d. Substitutions: See Division 01 – General Requirements.

D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
   1. Manufacturers:
      a. 3M
      b. American Polywater Corporation
      c. Ideal Industries, Inc.
      d. Substitutions: See Division 01 – General Requirements.

E. Cable Ties: Material and tensile strength rating suitable for application.
   1. Manufacturers:
      a. Burndy LLC.
      b. Substitutions: See Section 01 - Product Requirements.
   2. Provide plenum rated cable ties.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as shown on the drawings.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated and routing is not shown, determine exact routing.
   3. Arrange circuiting to minimize splices.
   4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   5. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted where indicated:
      a. Dedicated neutral conductors are considered current-carrying conductors.
      b. Increase size of conductors to account for ampacity derating.
      c. Size raceways, boxes to accommodate conductors installed.
   7. Common Neutrals: Not allowed.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install aluminum conductors in accordance with NECA 104.

E. Install metal-clad cable (Type MC) in accordance with NECA 120 and:
   1. Shall be supported at intervals not exceeding 5 ft.
   2. Shall be routed perpendicular and parallel to building lines.
   3. Shall be independently supported from structure.
   4. Shall be grouped in common runs using UL listed, steel, galvanized cable support brackets.
   5. All cable ties used shall be plenum rated.

F. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
   1. Installation above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
   2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

I. Terminate cables using suitable fittings.
   1. Metal-Clad Cable (Type MC):
      a. Use listed fittings.
      b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
      c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.
      d. Secure at maximum interval of 5 ft.
      e. Install parallel and perpendicular to building lines.
      f. Bundle cables in common routes back to panelboards.
      g. Secure from structure using suitable J-hooks or plenum rated cable ties.

J. Install conductors with a minimum of 12 inches of slack at each outlet.

K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

N. Mineral Insulated Cable Installation:
   1. The wiring and cable shall be installed according to the manufacturers' recommendations, the instructions in the installation and specifications manual and the requirements of the UL Fire Resistance Directory listing.
   2. Provide brass glands, termination kits and fittings from the same manufacturer as the cable. Provide brass plates for entrance fittings to ferrous enclosures per the manufacturer's recommendations.

O. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Do not remove conductor strands to facilitate insertion into connector.
   3. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
   4. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
   5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

P. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to un-spliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
      b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
   2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
      b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
   3. Wet Locations: Use heat shrink tubing.

Q. Insulate ends of spare conductors using vinyl insulating electrical tape.

R. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

S. Identify conductors and cables in accordance with Section 26 0553.

T. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07.

U. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, for a complete operating system.

3.4 FIELD QUALITY CONTROL

A. See Division 01 – General Requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Chemically-enhanced ground electrodes.

G. Ground plate electrodes.

H. Ground enhancement material.

I. Ground access wells.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Division 03– Concrete.

C. Division 09 - Finishes.

D. Section 26 0400 – General Conditions for Electrical Trades

E. Section 26 0519 – Building Wire and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
1. Includes oxide inhibiting compound.

F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

G. Section 26 4100 – Facility Lightning Protection

H. Section 26 5100 - Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

I. Section 33 7900 - Site Grounding.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

E. NFPA 70 - National Electrical Code.

F. NFPA 780 - Standard for the Installation of Lightning Protection Systems.

G. UL 467 - Grounding and Bonding Equipment.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 SUBMITTALS

A. See Division 01 – General Requirements.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

C. Shop Drawings:
1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field quality control test reports.

F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:
1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

E. Grounding Electrode System:
1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
a. Provide continuous grounding electrode conductors without splice or joint.

b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.

2. Metal Underground Water Pipe(s):
   a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
   b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
   c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
3. Other Metal Piping:
   a. Provide connection to all metallic gas piping and miscellaneous metal piping of continuous lengths.
   b. Bond in accordance with NFPA 70.
   c. Size bonding conductor in accordance with NFPA 70.
4. Metal In-Ground Support Structure:
   a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
5. Concrete-Encased Electrode:
   a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
6. Ground Ring (Counterpoise):
   a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 3/0 AWG in direct contact with earth.
   b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
   c. Provide ground enhancement material around conductor where indicated.
   d. Provide connection from ground ring conductor to:
      1) Perimeter columns of metal building frame.
      2) Ground rod electrodes located as indicated.
      3) Building service equipment grounding bus.
7. Ground Rod Electrode(s):
   a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
   b. Space electrodes not less than 22 feet from each other and any other ground electrode.
   c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
   d. Provide ground enhancement material around electrode where indicated.
   e. Provide ground access well for each electrode.
8. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
9. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.

F. Service-Supplied System Grounding:
   1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
   2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
   6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
   7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
      a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
      b. Metal gas piping.
      c. Metal process piping.
   8. Provide bonding for interior metal air ducts.
   9. Provide bonding for metal building frame.
   10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
   11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.

H. Communications Systems Grounding and Bonding:
   1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
   2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
      a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
      b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
      c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
      d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

I. Facility Lightning Protection Systems, in Addition to Requirements of Section 26 4100:
   1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
   2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

J. Cable Tray Systems: Also comply with Section 26 0536.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.
         2) Use bare copper conductors where directly encased in concrete (not in raceway).
   2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equal gage of specified conductors.

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
      a. Exceptions:
         1) Use mechanical connectors for connections to electrodes at ground access wells.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
      a. Exceptions:
         1) Use exothermic welded connections for connections to metal building frame.
   4. Manufacturers - Mechanical and Compression Connectors:
      a. Advanced Lightning Technology (ALT)
      b. Burndy LLC.
      c. Harger Lightning & Grounding
      d. Thomas & Betts Corporation
      e. Substitutions: See Division 01 - General Requirements.
   5. Manufacturers - Exothermic Welded Connections:
      a. Burndy LLC.
      b. Cadweld, a brand of Erico International Corporation
      c. ThermOweld, a brand of Continental Industries, Inc. Substitutions: See Division 01 - General Requirements.

D. Ground Bars:
   1. Description: Copper rectangular ground bars with mounting brackets and insulators.
   2. Size: As indicated.
   3. Holes for Connections: As indicated or as required for connections to be made.
   4. Manufacturers:
      a. Advanced Lightning Technology (ALT)
      b. Erico International Corporation
      c. Harger Lightning & Grounding
      d. ThermOweld, a brand of Continental Industries, Inc.
      e. Substitutions: See Division 01 - General Requirements.

E. Ground Rod Electrodes:
   1. Comply with NEMA GR 1.
   2. Material: Copper-bonded (copper-clad) steel.
   3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
   4. Where rod lengths of greater than 10 feet are indicated or used, sectionalized ground rods are acceptable.
   5. Manufacturers:
      a. Advanced Lightning Technology (ALT)
      b. Erico International Corporation
      c. Galvan Industries, Inc.
      d. Harger Lightning & Grounding
      e. Substitutions: See Division 01 - General Requirements.

F. Chemically-Enhanced Ground Electrodes:
   1. Description: Copper tube factory-filled with electrolytic salts designed to provide a low-impedance ground in locations with high soil resistivity; straight (for vertical installations) or L-shaped (for horizontal installations) as indicated or as required.
   2. Length: 10 feet.
   3. Integral Pigtail: Factory-attached, sized not less than grounding electrode conductor to be attached.
   4. Backfill Material: Grounding enhancement material recommended by electrode manufacturer.
   5. Manufacturers:
      a. Advanced Lightning Technology (ALT)
      b. Erico International Corporation
      c. Harger Lightning & Grounding
      d. ThermOweld, subsidiary of Continental Industries
      e. Substitutions: See Division 01 - General Requirements.

G. Ground Plate Electrodes:
   1. Material: Copper.
   2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.
   3. Manufacturers:
      a. Advanced Lightning Technology (ALT)
      b. Erico International Corporation
      c. Harger Lightning & Grounding
      d. ThermOweld, subsidiary of Continental Industries
      e. Substitutions: See Division 01 - General Requirements.

H. Ground Enhancement Material:
   1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.

2. Resistivity: Not more than 20 ohm-cm in final installed form.
3. Manufacturers:
   a. Erico International Corporation
   b. Harger Lightning & Grounding
   c. ThermOweld, subsidiary of Continental Industries
   d. Substitutions: See Division 01 - General Requirements.

I. Ground Access Wells:
1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
   a. Areas Exposed to Light Vehicular Traffic: Rated for not less than 22,500 pounds vertical design load.
2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
   a. Round Wells: Not less than 8 inches in diameter.
   b. Rectangular Wells: Not less than 12 by 12 inches.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".
5. Manufacturers:
   a. Advanced Lightning Technology (ALT)
   b. Erico International Corporation
   c. Harger Lightning & Grounding
   d. ThermOweld, subsidiary of Continental Industries
   e. Substitutions: See Division 01 - General Requirements.

J. Oxide Inhibiting Compound: Comply with Section 26 0519.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as shown on the drawings.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches deep in accordance with NFPA 70 or provide ground plates.

1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.

E. Make grounding and bonding connections using specified connectors.
1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

F. Install in accordance with IEEE 142.

G. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.

H. Install grounding and bonding conductors concealed from view.

I. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

J. Install continuous grounding using underground cold water system, driven rods and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.

K. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

L. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

M. Common Ground Bonding with Lightning Protection System: Bond electric power system, grounding electrode system directly to lightning protection system earth connection at closest point to electric service grounding electrode. Use bonding conductor sized the same as system grounding conductor and install in conduit.

N. Permanently attach equipment and grounding conductors prior to energizing equipment.

O. Identify grounding and bonding system components in accordance with Section 26 0553.

P. Bond the equipment grounding buses for the normal and critical branch circuit panelboards serving the same patient care vicinity with an insulated, continuous #10 AWG copper conductor.

3.4 COUNTERPOISE

A. Bury counterpoise not less than 30 inches below grade and 5 feet from the building foundation. Use #3/0 conductor and for taps to building steel. Fill trench with ground enhancement material a minimum of 1” above and below the conductor.

B. Ground the steel frame of the building with a ground rod at every corner column and at every other exterior column. Locate ground rods at counterpoise trench and attach to the counterpoise conductor. The top of the ground rod shall be not less than 24” below grade

3.5 FIELD QUALITY CONTROL

A. See Division 01 - General Requirements.

B. Inspect and test in accordance with NETA ATS except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13.

D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Support and attachment components for electrical equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Division 03 - Cast-in-Place Concrete: Concrete equipment pads.

C. Section 26 0400 – General Conditions for Electrical Trades

D. Section 26 0533 – Raceways and Boxes: Additional support and attachment requirements.

E. Section 26 5100 - Lighting: Additional support and attachment requirements for luminaires.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.

D. MFMA-4 - Metal Framing Standards Publication; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Division 01: Requirements for Coordination.

B. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.

2. Coordinate the work with other trades and provide additional framing and materials for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

C. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Division 03.

1.5 SUBMITTALS

A. Division 01 - General Requirements.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

D. Installer's Qualifications: Include evidence of compliance with specified requirements.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with latest adopted version of applicable building code, including any addendum or supplements.

C. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

D. Installer Qualifications for Field-Welding: As specified in Section 26 0400 General Conditions for Electrical Trades.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
1. Provide all hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
   a. Indoor Dry Locations: Use zinc-plated steel or approved equal unless otherwise indicated.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equal unless otherwise indicated.
   c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
   d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Materials for Metal Fabricated Supports: Comply with Division 05.

C. Conduit and Cable Supports: Straps, clamps, suitable for the conduit or cable supported.
1. Conduit Straps: One-hole or two-hole type; steel.
2. Conduit Clamps: Bolted type unless otherwise indicated.
3. Manufacturers:
   a. Cooper Crouse-Hinds, a division of Eaton Corporation
   b. Erico International Corporation
   c. O-Z/Gedney, a brand of Emerson Industrial Automation
   d. Thomas & Betts Corporation
   e. Substitutions: See Division 01 - General Requirements.

D. Outlet Box Supports: Hangers, brackets, suitable for the boxes supported.
1. Manufacturers:
   a. Cooper Crouse-Hinds, a division of Eaton Corporation
   b. Erico International Corporation
   c. O-Z/Gedney, a brand of Emerson Industrial Automation
   d. Thomas & Betts Corporation
   e. Substitutions: See Division 01 - General Requirements.

E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware for field-assembly of supports.
1. Comply with MFMA-4.
2. Channel Material:
   a. Indoor Dry Locations: Use galvanized steel.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.

4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
5. Manufacturers:
   a. Cooper B-Line, a division of Eaton Corporation
   b. Thomas & Betts Corporation
   c. Unistrut, a brand of Atkore International Inc.
   d. Substitutions: See Division 01- General Requirements.
   e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated:
   a. Equipment Supports: 1/2 inch diameter.
   b. Single Conduit up to 1 inch trade size: 1/4 inch diameter.
   c. Single Conduit larger than 1 inch trade size: 3/8 inch diameter.
   d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
   e. Outlet Boxes: 1/4 inch diameter.
   f. Luminaires: 1/4 inch diameter.

G. On-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
1. Base Sizes: Size to distribute load sufficiently to prevent indentation of roofing assembly.
2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for indoor hangers and supports.
3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
4. Manufacturers:
   a. Cooper B-Line, a division of Eaton Corporation
   b. Erico International Corporation
   c. PHP Systems/Design
   d. Unistrut, a brand of Atkore International Inc.
   e. Substitutions: See Division 01 - General Requirements.

H. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Plastic and lead anchors are not permitted.
10. Powder-actuated fasteners may be used with:
   a. Permission by Architect.
   b. Permission by Structural Engineer.
   c. Use only threaded studs; do not use pins.
11. Hammer-driven anchors and fasteners are permitted as follows:
   a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction (when specified).
   b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction (when specified).

12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Comply with MFMA-4.
    b. Channel Material: Use galvanized steel.
    c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
    d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
13. Manufacturers - Mechanical Anchors:
    a. Hilti, Inc.
    b. ITW Red Head, a division of Illinois Tool Works, Inc.
    c. Powers Fasteners, Inc.
    d. Simpson Strong-Tie Company Inc.
    e. Substitutions: See Division 01 - General Requirements.
14. Manufacturers - Powder-Actuated Fastening Systems:
    a. Hilti, Inc.
    b. ITW Ramset, a division of Illinois Tool Works, Inc. Powers Fasteners, Inc.
    c. Simpson Strong-Tie Company Inc.
    d. Substitutions: See Division 01 - General Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Equipment Support and Attachment:
    1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment.

2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 4 inch high concrete pad constructed in accordance with Division 03.
5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Conduit Support and Attachment: Also comply with Section 26 0534.

I. Cable Tray Support and Attachment: Also comply with Section 26 0536.

J. Box Support and Attachment: Also comply with Section 26 0537.

K. Luminaire Support and Attachment: Also comply with Section 26 5100.

L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

M. Secure fasteners according to manufacturer's recommended torque settings.

N. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

A. Division 01 - General Requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 260533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Conduit Applications
2. General Requirements
3. Galvanized steel rigid metal conduit (RMC).
4. Intermediate metal conduit (IMC)
5. PVC-coated galvanized steel rigid metal conduit (RMC).
6. Flexible metal conduit (FMC).
7. Liquidtight flexible metal conduit (LFMC).
8. Electrical metallic tubing (EMT).
9. Rigid polyvinyl chloride (PVC) conduit.
10. Liquidtight flexible nonmetallic conduit (LFNC).
11. Non-metallic tubing
12. Surface metal raceway
13. Wireway
14. Boxes
15. Accessories.

B. Related Sections:
1. Section 260503 - Equipment Wiring Connections.
2. Section 260519 – Building Wire and Cable.
3. Section 260526 - Grounding and Bonding for Electrical Systems.
4. Section 260529 - Hangers and Supports for Electrical Systems.
5. Section 260534 - Floor Boxes for Electrical Systems.
6. Section 260553 - Identification for Electrical Systems.
7. Section 262726 - Wiring Devices.
8. Section 270533 - Conduits and Backboxes for Communications Systems.
9. Section 280533 - Conduit and Backboxes for Electronic Safety and Security.

1.2 REFERENCES

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC);

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S);

C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A);

D. NECA 1 - Standard for Good Workmanship in Electrical Construction;

E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT);

F. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit;

G. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC);

H. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable;

I. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; .

J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit;

K. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing;

L. NEMA TC 13 - Electrical Nonmetallic Tubing (ENT);

M. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

N. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

O. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.

P. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

Q. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

R. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

S. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

T. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

U. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

V. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

W. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

X. UL 1653 - Electrical Nonmetallic Tubing; Current Edition, Including All Revisions.

Y. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

Z. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

AA. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

BB. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

CC. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.3 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

A. See Division 01 – General Requirements.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for all conduits and fittings outlined in Part 2.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

D. Shop Drawings:
1. Indicate proposed arrangement for conduits to be installed within or under structural concrete slabs, where permitted.
2. Include proposed locations of roof penetrations and proposed methods for sealing.

E. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs (where permitted), and conduits 2 inch trade size and larger.

F. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

G. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 – General Requirements.
2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Division 01 – General Requirements

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

D. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

1.8 COORDINATION

A. See Division 01 – General Requirements

B. Coordinate installation of outlet boxes for equipment connected under Section 260503.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

D. Electrical contractor is responsible to fully coordinate with the site and concrete contractors and all other trades when routing conduit underslab. Routing of conduit underslab may be acceptable, provided spacing of conduits is adequate for proper backfilling of area surrounding conduits. Adequate spacing shall mean using factory made conduit spacers that allow for a minimum of 3-inches for backfilling with sand or 3 times the pipe diameter for backfilling with a structural fill. Proposed conduit routing, installation and methods and backfilling procedures shall be submitted to the Engineer for review prior to installation.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

C. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications listed below. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
   1. Underground:
      a. Under Slab on Grade: Use schedule 40 rigid PVC conduit with galvanized steel rigid metal conduit sweeps. Provide cast metal boxes or nonmetallic handhole. Applications limited to:
         1) Panelboard feeders
         2) Floor boxes
         3) Free-standing equipment and millwork.
         4) 20A single phase branch circuits from a panleboard to an area, where branch circuit exits slab in a coordinated location in a closet or back of house space and extends to device termination above an accessible ceiling. Stub up locations must be coordinated with the Architect and Owner prior to installation to avoid and shelving, storage or equipment installations.
      b. Exterior, Within Trench: Use schedule 40 or schedule 80 rigid PVC conduit with galvanized steel rigid metal conduit sweeps. Provide cast metal boxes or nonmetallic handhole.
      c. Exterior, Concrete Encased: Use Type EB rigid PVC conduit. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
   2. Embedded Within Concrete:
      a. Within Slab on Grade: Floor box applications only
      b. Within Slab Above Ground: Not permitted.
      c. Within Concrete Walls Above Ground: Use Type EB rigid PVC conduit. Provide flush mounted box rated for masonry applications.
   3. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT). Provide flush mounted boxes rated for masonry applications.
   4. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT) or MC cable (where allowed). Provide flush mounted sheet-metal boxes.
   5. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT) or MC cable (where allowed).
   6. Interior, Damp or Wet Locations Provide:
      a. Rigid steel conduit
      b. Electrical metallic tubing (EMT) with compression fittings
      c. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
   7. Exposed, Interior dry locations: Use electrical metallic tubing (EMT)
   8. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
      a. Locations subject to physical damage include, but are not limited to:

1) Where exposed below 8 feet, except within electrical and communication rooms or closets.

9. Exposed, Exterior: Use galvanized steel rigid metal conduit
10. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
    a. Maximum Length: 6 feet.
11. Connections to Vibrating Equipment:
    a. Dry Locations: Use flexible metal conduit or MC Cable.
    b. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
    c. Maximum Length: 6 feet unless otherwise indicated.
    d. Vibrating equipment includes, but is not limited to:
        1) Transformers.
        2) Motors.
        3) Pumps.
        4) Fans.
12. Exposed Dry Finished Locations: Provide surface metal raceway and fittings. Unless specified on drawings, requires design team approval for use of surface metal raceway in finished locations. Coordinate all vertical runs of surface raceway with the architect prior to installation.

2.2 GENERAL REQUIREMENTS

A. Fittings for Grounding and Bonding: Also comply with Section 260526.

B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Minimum Conduit Size, Unless Otherwise Indicated:
1. Branch Circuits: 3/4 inch trade size.
2. Branch Circuit Homeruns: 3/4 inch trade size.
3. Control Circuits: 1/2 inch trade size.
4. Flexible Connections to Luminaires: 3/4 inch trade size.
5. Underground, Interior: 1 inch trade size.
6. Underground, Exterior: 1 inch trade size.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: See Division 01 – General Requirements.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:
1. Manufacturers:
    a. Bridgeport Fittings Inc.
    b. O-Z/Gedney.
    c. Thomas & Betts Corporation.
    d. Substitutions: See Division 01 – General Requirements

2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
4. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: See Division 01 – General Requirements.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
1. Manufacturers:
   a. Bridgeport Fittings Inc
   b. O-Z/Gedney, a brand of Emerson Industrial Automation
   c. Thomas & Betts Corporation
   d. Substitutions: See Division 01 – General Requirements
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel.
   a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use threaded type or compression fittings only.

2.5 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
1. Carlon Electrical Products.
2. Allied Tube and Conduit.
3. AFC Cable Systems, Inc
4. Substitutions: See Division 01 – General Requirements.

B. B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:
1. Manufacturers:
   a. Bridgeport Fittings Inc
   b. O-Z/Gedney, a brand of Emerson Industrial Automation
   c. Thomas & Betts Corporation
   d. Substitutions: See Division 01 – General Requirements
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel.
   a. Do not use die cast zinc fittings.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
1. Carlon Electrical Products.
2. Allied Tube and Conduit.
3. AFC Cable Systems, Inc
4. Substitutions: See Division 01 – General Requirements

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
1. Manufacturers:
a. Bridgeport Fittings Inc
b. O-Z/Gedney, a brand of Emerson Industrial Automation
c. Thomas & Betts Corporation
d. _____.
e. Substitutions: See Division 01 – General Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel
a. Do not use die cast zinc fittings.

2.7 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: See Division 01 – General Requirements

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:
1. Manufacturers:
a. Bridgeport Fittings Inc
b. O-Z/Gedney, a brand of Emerson Industrial Automation
c. Thomas & Betts Corporation
d. Substitutions: See Division 01 – General Requirements
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel.
4. Connectors and Couplings: Use compression (damp or wet location)or set-screw type elsewhere

2.8 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:
1. Cantex Inc
2. Carlon, a brand of Thomas & Betts Corporation
3. JM Eagle
4. Substitutions: See Division 01 – General Requirements

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.9 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:
1. AFC Cable Systems, Inc
2. Electri-Flex Company
3. International Metal Hose
4. _____.
5. Substitutions: See Division 01 – General Requirements

B. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.10 SURFACE METAL RACEWAY

A. Manufacturers:
1. Hubbell Wiring Devices.
2. Thomas & Betts Corp.
3. The Wiremold Co.
4. Substitutions: Division 01 - General Requirements.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. General:
1. System: Provide surface raceway systems for branch circuit and data network voice, video and other low-voltage wiring. Surface raceway system shall consist of raceway bases, covers, pre-divided raceway bases, dual covers, appropriate fittings and device mounting plates necessary for a complete installation.
2. Configuration: Raceways shall be one- or two-piece design with base and snap-on cover, or three-piece design with base and two snap-on covers which snap side by side on a common base. Base shall be dividable with a fixed barrier for up to 4 compartments. Raceway shall be available in widths of 3/4" to 10" and depths of 17/32" to 5" Provide raceways from a company that can provide custom sizes if required. Raceway covers shall be available in tamper-resistant form with screws on access plates and covers of fittings, but not on standard cover lengths. Raceways shall be multi-piece design with metal base and snap-on metal covers. Assembled base and cover is 5-3/4" wide by 2-1/8" high with a cross section area of 10.06 sq in. Base shall have 2 wiring channels, separated by 1 integral divider, large enough to accept standard power and communication devices without restricting capacity of the adjacent channel. The raceway base

shall accept 2 covers that allow separation of services. The cover shall slightly curve and form the raceway sidewall. Provide the base with scored lines to facilitate sectioning of the raceway in 4" increments and include mounting holes, and tunnel knockouts in the divider wall that will facilitate the crossing over of services.

3. Fittings: Fittings shall include flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable. Where required, provide tamper-resistant form, dividable with barriers and matching the size of the accompanying raceway base. Provide full capacity corner elbows and tee fittings to maintain a controlled 2" cable bend radius, meeting the specification for Fiber Optic and UTP cabling and exceeding the TIA/EIA-569-A requirements for communications pathways.
4. Device Brackets and Plates: Provide in sizes to match raceway width and with mounting holes located to ensure proper mounting of devices in up to 4 compartments. Device plates shall be available in any length from 6" to 60", with cutouts to accommodate various combinations of power and communications devices in up to 4 compartments. Provide 6" and 12" long device plates with a flange to overlap the joint of adjacent cover as applicable.
5. Communications Devices and Accessories: Raceway shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Where indicated, provide connectivity outlets and modular inserts by Ortronics or approved equal.

D. Classification:
1. Raceway and system components shall be UL and CUL listed.
2. Surface raceways shall be suitable for use in dry interior locations only, as covered in Article 386 (Surface Metal Raceways) 388 (Surface Nonmetallic Raceways) of the National Electrical Code.
3. Surface metal raceways and fittings shall be listed by Underwriters Laboratories under File Number E4376, Listing and Classification Number RJBT and File Number E41751, Listing and Classification Number RJPR respectively.
4. Systems shall comply with UL Standard UL5 for Surface Metal Raceways.
5. Larger 2 and 3 channel non-metallic raceways shall be UL Listed under File Nos. E90378 Guide RJTX and E90377 Guide RJYT, respectively.

E. Surface Mounted Metal Raceways: V700 One-Piece Metal Raceway, G4000 Series Multi-Channel Steel Raceway, V2100 Single-Channel Metal Raceway by The Wiremold Company or approved equal.
1. Material: Galvanized steel, minimum thickness 0.040".
2. Finish: Factory-applied polyester topcoat applied over ivory base suitable for field-applied topcoat, color by Architect.
3. Steel Device Brackets and Plates: Steel overlap device plate for horizontal installation of devices. Plate shall overlap cover to conceal seam.
4. Plastic Overlapping Cover Bracket and Faceplate: Plastic device mounting bracket and trim plate for horizontal installation of devices. Plate shall overlap cover to conceal seam. Faceplate shall accept a variety of power and data/communication devices. Plastic shall be compatible with UL 94 for Plastic.
5. Adjustable Length Raceway Couplings: Provide raceway base sections with adjustable couplings. Each pair of couplings works in conjunction with the raceway base’s scored lines to allow less accurate field cuts. The coupling shall accommodate 4" of lateral movement and facilitate the ability of the raceway to maintain coordination with the wall framing as required. Each coupling shall provide a means of adding supplemental ground screws.

6. Fittings: Fittings shall include flat, internal and external elbows, tees, entrance fittings, wire clips, cover clips, couplings, support clips, and end caps. Covers for fittings shall overlap adjoining raceway covers a minimum of 3/8". Fittings shall be color matched to the raceway. Supply fittings with a base where applicable to eliminate mitering. Provide fittings with adjustable couplings that integrate with the raceway base. Provide a take-off fitting supporting dual services to adapt to existing flush wall boxes and other series of metallic raceways. Fittings shall have provisions to accept tamper resistant fasteners to fully secure the raceway.
   a. Fiber Optic/UTP/STP Fittings: Corner elbows, tees, and entrance end fittings as required to maintain a controlled 2" nominal cable bend radius that meets the specifications for Fiber Optic and UTP/STP cabling and exceeds TIA 569 requirements for communications pathways.
   b. Obstacle Avoidance and Offset Fittings: Provide fittings as required to bypass large and small obstacles and small offsets in supporting wall. Small obstacle avoidance fitting capable of being converted into a take off fitting to transition to other metallic raceways.
7. Device Brackets and Plates:
   a. Forward Fittings: Provide device brackets to install single-gang devices horizontally in either channel within the raceway. Provide horizontal device brackets with a single gang face plate. Horizontal device mounting brackets shall be a single piece with integral auxiliary grounding points. Device brackets and activation face plates shall allow the electrical or communications devices to face forward from the sidewall of the raceway.
   b. Communications Devices and Accessories: Raceway shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Provide with complete line of preprinted station and port identification labels.

F. Multi-service in wall boxes:
1. Multi-Service In-Wall Boxes: WallSource™ Multi-Service Box by The Wiremold Company or approved equal.
   a. Provide construction box system for bringing power and low voltage devices to one location or to back feed surface wiring systems. System shall consist of in-the-wall boxes, mounting brackets, dividers, device mounting brackets, trim rings, and device plates for a complete installation in accordance with the Drawings.
   b. Material: 0.050" thick galvanized steel with gray or ivory suitable for field painting.
2. Classification and Use: Provide construction box system to be utilized in dry, interior locations only as defined by Article 300-15 of the National Electrical Code, as adopted by the National Fire Protection Association and approved by the American National Standards Institute. The box and system components shall be UL listed in accordance with UL 514A and UL514C. The device mounting bracket shall be molded from color matching UL approved resin.
3. Boxes: Each box shall include the box, dividers and mounting brackets. Dimensions of each shall be a minimum of 32 cubic inches per gang and shall be manufactured of 16-gage minimum thick steel. The box shall accommodate standard power and communication devices.
   a. The 2-gang box shall have knockouts located on top and bottom, 2-1/4" from the face to accommodate combinations of 1/2", 3/4", and 1" trade size conduits. Boxes of 4- or 6-gangs shall have knockouts to accommodate 1-1/2" trade size conduits.

b. Box shall have a separate ground terminal provided in each gang.
c. Box shall adjust for a flush installation with the finished wall. There shall be positive stops for surface mounting to 1/2", 5/8", 1" and 1-1/4" thick wallboard. Adjusting screws shall be located outside the box for adjustment prior to installation.

4. Device Mounting Brackets: Self-leveling device mounting bracket shall accommodate standard power devices, connectivity inserts, and Wiremold 5507 series faceplates. Mounting bracket shall be available to accommodate other manufacturer's devices. Mounting bracket shall accommodate six power devices or 18 communications inserts. All faceplates, mounting brackets and trim rings shall be color matched.
5. Communication Devices and Accessories: Box shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Where indicated, provide connectivity outlets and modular inserts by Ortronics or approved equal.
6. Fiber Optic/UTP (including Category 5, 5e, 6) Radius: The depth of the box shall accommodate a 1-1/4" cable bend radius, which meets or exceeds the specifications for fiber optic and UTP cabling and TIA/EIA-569A requirements for communications pathways. A 1" controlled radius storage loop shall be available.
7. Device Covers: Device cover plates in the following configurations shall be available: duplex device cover plates, single 1.40" and 1.59" diameter receptacle cover plates, switch plates, GFCI cover plates, Sentrex surge receptacle cover plates and other rectangular faced plates. Single gang cover plates shall be modular in design.
8. Support Bracket: Provide support bracket for mounting on 16" on center studs on boxes with more than two gangs.
9. Dividers: Dividers shall be removable without any tools.

G. Finish: Architect to select from manufacturers standard color palette.

2.11 WIREWAY

A. Manufacturers:
1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Hoffman.
4. Substitutions: See Division 01 – General Requirements

B. Product Description: General purpose type wireway.

C. Knockouts: Manufacturers standard.

D. Cover: Screw cover.

E. Connector: Flanged.

F. Fittings: Lay-in type with removable top, bottom, and side; captive screws.

G. Finish: Rust inhibiting primer coating with gray enamel finish.

2.12 BOXES

A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Manufacturers:
a. Cooper Crouse-Hinds, a division of Eaton Corporation
b. Hubbell Incorporated; Bell Products
c. Hubbell Incorporated; RACO Products
d. Leviton
e. O-Z/Gedney, a brand of Emerson Industrial Automation
f. Thomas & Betts Corporation
g. Substitutions: See Division 01 – General Requirements
2. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
3. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
4. Use cast iron boxes or cast aluminum boxes with threaded hubs where exposed galvanized steel rigid metal conduit is used.
5. Use cast aluminum boxes with threaded hubs where aluminum rigid metal conduit is used.
6. Use nonmetallic boxes where exposed rigid PVC conduit is used.
7. Use suitable concrete type boxes where flush-mounted in concrete.
8. Use suitable masonry type boxes where flush-mounted in masonry walls.
9. Use raised covers suitable for the type of wall construction and device configuration where required.
10. Use shallow boxes where required by the type of wall construction.
11. Do not use "through-wall" boxes designed for access from both sides of wall.
12. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
13. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
14. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
15. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
16. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
17. Minimum Box Size, Unless Otherwise Indicated:
a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep trade size.

b. Communications Systems Outlets:
   1) Minimum 4 inch square by 2-1/8 inch trade size.
   2) Provide with single-gang drywall ring.
   3) Comply with Section 27 0533.
c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep trade size.

18. Wall Plates: Comply with Section 26 2726.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches :
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
   a. Indoor Clean, Dry Locations: Type 1, painted steel.
   b. Outdoor Locations: Type 3R, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches :
   a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
   b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
   a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
   b. Back Panels: Painted steel, removable.
   c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
   d. Provide with grounding stud.
   e. Provide with document pocket in cover.
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:
   a. Cooper B-Line, a division of Eaton Corporation
   b. Hoffman, a brand of Pentair Technical Products
   c. Hubbell Incorporated; Wiegmann Products
   d. Substitutions: See Division 01 – General Requirements

2.13 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

C. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force (890 N).

D. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

E. Mechancal Sleeve Seals

F. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.

3. PSI Link-Seal.
4. Substitutions: See Division 01 – General Requirements

G. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

H. Use: Provide for all penetrations through foundation walls.

PART 3 EXECUTION

3.1 EXAMINATION

A. See Division 01 – General Requirements.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

C. Verify that field measurements are as shown on drawings.

D. Verify that mounting surfaces are ready to receive conduits.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 260526.

B. Where metallic conduit sweeps or sleeves are used for single grounding electrode and bonding conductors provide with grounding bushings at each and bond to conductor at each end using the same size bonding jumper.

C. Fasten raceway and box supports to structure and finishes in accordance with Section 260529.

D. Identify raceway and boxes in accordance with Section 260553.

E. Arrange raceway and boxes to maintain headroom and present neat appearance.

F. Install products in accordance with manufacturer's instructions.

G. Perform work in accordance with NECA 1 (general workmanship).

H. Conduit Routing:
1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Unless otherwise approved, do not route conduits exposed:
   a. Across floors.
   b. Across roofs.
   c. Across top of parapet walls.
   d. Across building exterior surfaces.

e. Interior finished spaces.

5. Conduits installed underground or embedded in concrete (floor box applications only) may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
6. Arrange conduit to maintain adequate headroom, clearances, and access.
7. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
8. Arrange conduit to provide no more than 150 feet between pull points.
9. Route conduits above water and drain piping where possible.
10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
12. Maintain minimum clearance of 12 inches between conduits and surfaces exceeding 104 degrees F. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
13. Group parallel conduits in the same area together on a common rack.

I. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
    a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
9. Use of spring steel conduit clips for support of conduits is not permitted.
10. Use of wire for support of conduits is not permitted.

J. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs 6” above finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.

K. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases. Seal conduit with spray foam watertight sealant after cable is installed and tested with Polywater AFT spray foam sealant or approved equal.
6. Provide suitable mechanical sleeve seals where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
9. Provide metal escutcheon plates for conduit penetrations exposed to public view.
10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07.

3.3 INSTALLATION – BOXES

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide separate boxes for emergency power and normal power systems.

E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Install gang box with plaster ring for single device outlets.

I. Box Locations:
   1. Locate boxes to be accessible. Provide access panels in accordance with Division 08 as required where approved by the Architect.
   2. Unless dimensioned, box locations indicated are approximate.
   3. Locate boxes as required for devices installed under other sections or by others.
      a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 262726.
      b. Communications Systems Outlets: Comply with Section 270533.
   4. Locate boxes so that wall plates do not span different building finishes.
   5. Locate boxes so that wall plates do not cross masonry joints.
   6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
   7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
   8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
   9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
      a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
      b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
   10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260534.

J. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 260529.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
   4. Install stamped steel bridges to fasten flush mounting outlet box between studs.
   5. Install adjustable steel channel fasteners for hung ceiling outlet box.

K. Install boxes plumb and level.

L. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

M. Floor-Mounted Cabinets: Mount on properly sized 3 inch high concrete pad constructed in accordance with Division 03.

N. Install boxes as required to preserve insulation integrity.

O. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

P. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.

Q. Underground Boxes/Enclosures:
1. Install enclosure on gravel base, minimum 6 inches deep.
2. Flush-mount enclosures located in concrete or paved areas.
3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
4. Provide cast-in-place concrete collar constructed in accordance with Division 03, minimum 10 inches wide by 12 inches deep, around enclosures that are not located in concrete areas.
5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

R. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07.

T. Close unused box openings.

U. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

V. Provide grounding and bonding in accordance with Section 260526.

W. Identify boxes in accordance with Section 260553.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Locate outlet boxes to allow luminaires positioned as indicated on reflected ceiling plan.

B. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.5 ADJUSTING

A. See Division 01 – General Requirements Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused openings in boxes.

3.6 CLEANING

A. See Division 01 – General Requirements

B. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

C. Clean exposed surfaces and restore finish.

3.7 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 260534

FLOOR BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section “Summary”, Paragraph 1.1A, entitled “Related Documents.”

1.2 SUMMARY

A. Section includes floor boxes; floor box service fittings; poke-through fittings; and access floor boxes.

B. Related Sections:
1. Division 07 Section –Penetration Firestopping.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 27 26 - Wiring Devices: Receptacles for installation in floor boxes.

1.3 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog data for floor boxes service fittings.

C. Samples: Submit two of each service fitting illustrating size, material, configuration, and finish.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of each floor box and poke-through fitting.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 FLOOR BOXES

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.
4. Wiremold/Legrand.
5. Substitutions: Section 01 60 00 – Product Requirements.

B. Floor Boxes: NEMA OS 1.

C. Adjustability: Fully adjustable.

D. Material: Cast metal.

E. Shape: Rectangular.

2.2 FLUSH-COVER-TYPE CONVENIENCE RECEPTACLE SERVICE FITTING

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.
4. Wiremold/Legrand.
5. Substitutions: Section 01 60 00 – Product Requirements.

B. Material: Brass.

C. Configuration: Duplex flap opening.

2.3 FLUSH-COVER-TYPE COMMUNICATION OUTLET

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.
4. Wiremold/Legrand.
5. Substitutions: Section 01 60 00 – Product Requirements.

B. Material: Brass.

C. Configuration: Flap opening.

2.4 FLUSH-COVER-TYPE COMBINATION FITTING

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.
4. Wiremold/Legrand.
5. Substitutions: Section 01 60 00 – Product Requirements.

B. Material: Brass.

C. Configuration: Flap openings.

D. For use at single use instructor's stations and free standing administration millwork only.

2.5 Multi-service floor box

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Material: Cast-iron suitable for use on grade.

C. Configuration: Fully adjustable with four independent wiring compartments that allow capacity for up to four duplex outlets or communications devices. Box shall permit tunneling from adjacent or opposite compartments. Box shall provide a minimum of four 1" conduit hubs and four 1 1/4" conduit hubs.

D. Activation Cover: Die-cast flanged cover with brushed aluminum finish.

E. Accessories: Device mounting plates, faceplates and bezels for duplex receptacle and communications devices.

F. For use as indicated on drawings in new slab on grade construction.

2.6 POKE-THROUGH FITTINGS

A. Manufacturers:
1. Hubbell.
2. Leviton.
3. Wiremold/Legrand.
4. Substitutions: Section 01 60 00 – Product Requirements.

B. Product Description: Combination power/telecommunications assembly comprising service fittings, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.

C. Fire Rating: 3 hours.

D. Service Fitting Type: Flush.

E. Housing: cast aluminum.

F. Device Plate: Brass.

G. Configuration: Varies, provide with flush cover assemblies for receptacles, combination power/telecommunications or furniture feeds as indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3000 - Administrative Requirements: Coordination and project conditions.

B. Where use for a device is not specified, consult with Architect and Engineer prior to rough-in.

C. Verify locations of floor boxes and outlets in work areas prior to rough-in.

D. Verify openings in access floor are in proper locations.

3.2 INSTALLATION

A. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned. Adjust box location to accommodate intended purpose.

B. Floor Box Requirements: Use cast floor boxes or stamped steel with fusion epoxy coating for installations in slab on grade; formed steel boxes are acceptable for other installations.

C. Set floor boxes level.

D. Install boxes and fittings to preserve fire resistance rating of slabs and other elements, using materials and methods specified in Section 07 8400.

E. Install protective rings on active flush cover service fittings.

F. Confirm quantity of devices and cables intended for each box, and cable types before purchasing or setting devices.

3.3 ADJUSTING

A. Section 01 7000 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust floor box flush with finish flooring material.

3.4 CLEANING

A. Section 01 7000 - Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

END OF SECTION

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Warning signs and labels.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Division 09 - Finishes.

C. Section 26 0400 – General Conditions for Electrical Trades.

D. All of Divisions 26, 27 & 28.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.

C. NFPA 70 - National Electrical Code.

D. NFPA 70E - Standard for Electrical Safety in the Workplace

E. UL 969 - Marking and Labeling Systems.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Division 01- General Requirements

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Division 01 – General Requirements

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.8 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature and humidity is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:
1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
   a. Switchboards:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Use identification nameplate to identify main overcurrent protective device.
      5) Use identification nameplate to identify load(s) served for each branch device, including spares and prepared spaces.
   b. Panelboards:
      1) Identify ampere rating.

2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
5) Use typewritten circuit directory to identify load(s) served for panelboards with a door, including spares and spaces

c. Transformers:
1) Identify kVA rating.
2) Identify voltage and phase for primary and secondary.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify load(s) served. Include location when not within sight of equipment.

d. Enclosed switches, circuit breakers, and motor controllers including equipment serving HVAC and plumbing equipment:
1) Identify voltage and phase.
2) Identify power source and circuit number. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.

e. Time Switches:
1) Identify load(s) served and associated circuits controlled. Include location.

f. Enclosed Contactors:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
4) Identify coil voltage.
5) Identify load(s) and associated circuits controlled. Include location.

g. Electricity Meters:
1) Identify load(s) metered.

2. Service Equipment:
a. Use identification nameplate to identify each service disconnecting means.
b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.

3. Emergency System Equipment:
a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.

4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.

5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
6. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
7. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
8. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
9. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
10. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
    a. Service equipment.
    b. Motor control centers.
    c. Elevator control panels.
11. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
    a. Minimum Size: 3.5 by 5 inches.
    b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equal.
    c. Service Equipment: Include the following information in accordance with NFPA 70.
        1) Nominal system voltage.
        2) Available fault current.
        3) Clearing time of service overcurrent protective device(s).
        4) Date label applied.
12. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equal.
13. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equal.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
2. Identification for Communications Conductors and Cables: Comply with Section 27 0553.
3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
    a. At each source and load connection.
    b. Within boxes when more than one circuit is present.
    c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
    d. In cable tray, at maximum intervals of 20 feet.
5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
6. Use underground warning tape to identify direct buried cables.

C. Identification for Raceways:
1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
    a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
        1) Color Code:
            a) Emergency Power System: Red.
                (1) Life Safety Branch: YELLOW.
            b) Fire Alarm System: Red.
        2) Field-Painting: Comply with Division 09 - Finishes
        3) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.
3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
4. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
5. Use underground warning tape to identify underground raceways.
6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.

D. Identification for Cable Tray: Comply with Section 26 0536.

E. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
2. Use voltage markers or color coded boxes to identify systems other than normal power system.
    a. Color-Coded Boxes: Field-painted in accordance with Division 09 and the same color code used for raceways.
        1) Emergency Power System: Red.
            a) Life Safety Branch: YELLOW.
        2) Fire Alarm System: Red.
    b. For exposed boxes in public areas, do not color code.
3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
    a. For exposed boxes in public areas, use only identification labels.

F. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 27 0553.
2. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
3. Factory Pre-Marked Wallplates: Comply with Section 26 2726.
4. Use identification label to identify fire alarm system devices.
   a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
5. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
   a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
6. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
7. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

G. Identification for Luminaires:
1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Manufacturers:
   a. Brimar Industries, Inc.
   b. Kolbi Pipe Marker Co.
   c. Seton Identification Products
   d. Substitutions: Division 01 - General Requirements.
2. Materials:
   a. Indoor Clean, Dry Locations: Use plastic nameplates.
   b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
   a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
1. Manufacturers:
   a. Brady Corporation
   b. Brother International Corporation
   c. Panduit Corp.
   d. Substitutions: Division 01 - General Requirements.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   a. Use only for indoor locations.

3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
   a. System designation where applicable:
      1) Emergency Power System: Identify with text "EMERGENCY".
      2) Life Safety Branch: Identify with text "LIFE SAFETY"
      3) Fire Alarm System: Identify with text "FIRE ALARM".
   b. Equipment designation or other approved description.
   c. Other information as indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. System Designation: 1 inch.
   b. Equipment Designation: 1/2 inch.
   c. Other Information: 1/4 inch.
   d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
5. Color:
   a. Normal Power System: White text on black background.
   b. Emergency Power System: White text on red background.
      1) Life Safety Branch: White text on YELLOW background.
   c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.
   a. Exceptions:
      1) Provide white text on red background for general information or operational instructions for emergency systems.
      2) Provide white text on red background for general information or operational instructions for fire alarm systems.

E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
   a. Include voltage and phase for other than 120 V, single phase circuits.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Control Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Manufacturers:
1. Brady Corporation
2. HellermannTyton
3. Panduit Corp.
4. Substitutions: Division 01 - General Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
1. Do not use self-adhesive type markers.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
1. Do not use handwritten text.

F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

A. Manufacturers:
1. Brady Corporation
2. Brimar Industries, Inc.
3. Seton Identification Products
4. Substitutions: Division 01 - General Requirements.

B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

D. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
   2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
   3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
   4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.

E. Legend:
   1. Markers for Voltage Identification: Highest voltage present.
   2. Markers for System Identification:
      a. Emergency Power System: Text "EMERGENCY".
      b. Other Systems: Type of service.

F. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

A. Manufacturers:
   1. Brady Corporation
   2. Brimar Industries, Inc.
   3. Seton Identification Products
   4. Substitutions: Division 01 - General Requirements.

B. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil (0.1 mm), unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:
   1. Tape for Buried Power Lines: Black text on red background.
   2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.6 WARNING SIGNS AND LABELS

A. Manufacturers:
   1. Brimar Industries, Inc.
   2. Clarion Safety Systems, LLC.
   3. Seton Identification Products
   4. Substitutions: Division 01 - General Requirements.

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
      b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
   2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
   3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:
1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
a. Do not use labels designed to be completed using handwritten text.
b. Provide polyester overlaminate to protect handwritten text.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conduits: Legible from the floor.
8. Boxes: Outside face of cover.
9. Conductors and Cables: Legible from the point of access.
10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

A. See Division 01 - General Requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 260573

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes electrical connections to equipment.

B. Related Sections:
1. Section 26 05 19 – Building Wire and Cable.

1.2 SECTION INCLUDES

A. Performance requirements for overcurrent protective devices.

B. Short circuit study.

C. Coordination study and analysis.

1.3 RELATED REQUIREMENTS

A. Section 26 24 13 - Switchboards: Overcurrent protective devices in switchboards.

B. Section 26 24 16 - Panelboards: Overcurrent protective devices in panelboards.

1.4 REFERENCE STANDARDS

A. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001.

B. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

C. NFPA 70 - National Electrical Code; 2011.

1.5 SUBMITTALS

A. See Section 01 31 00 - Project Management, Coordination and Commissioning: for submittal procedures.

B. Study Preparer's Qualifications.

C. Study Report: Submit protective device studies as specified, prior to submission of product data submittals or ordering or fabrication of protective devices.
1. Evaluation of product data submittals by Engineer will not commence until acceptable preliminary studies in sufficient detail to ensure that device selection will be adequate have been submitted.
2. Include stamp or seal and signature of preparing engineer.

D. Product Data: In addition to submittals specified elsewhere, submit manufacturer's time-current curves for all protective devices.

E. Field Engineer Qualifications.

F. Field Inspection Report: Show final adjusted settings of protective devices.

G. Certificates: Prior to final inspection, certify that field adjustable protective devices have been set in accordance with requirements of protective device analysis.

H. Project Record Documents: Revise protective device study as required to show as-built conditions.
1. Submit not less than 60 days prior to final inspection of electrical system.
2. Include hard copies in operation and maintenance data submittals.
3. Include all files prepared using software packages, on CD-ROM, with file name cross-references to specific pieces of equipment and systems.

1.6 PROTECTIVE DEVICE STUDY

A. Analyze the specific electrical and utilization equipment (according to NEC definition), the actual protective devices to be used, and the actual feeder lengths to be installed.
1. Scope of Studies:
a. All new emergency and essential system distribution wiring and equipment, from primary source (including generator) to transfer switches, buses and emergency branch circuit panelboards.
b. All new normal system distribution wiring and equipment, from primary source (including generator) to transfer switches, buses and emergency branch circuit panelboards.
2. Primary Source, for Purposes of Studies: Utility company primary protective devices.
3. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.
4. Report: State the methodology and rationale employed in making each type of calculation; identify computer software package(s) used.

B. One-Line Diagrams: Prepare schematic drawing of the emergency electrical and normasl electrical distribution system, with all electrical equipment and wiring to be protected by the protective devices; identify nodes on the diagrams for reference on report that includes:
1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at the main switchboard bus and all downstream devices containing protective devices.
2. Breaker and fuse ratings.
3. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
4. Identification of each bus, with voltage.
5. Conduit materials, feeder sizes, actual lengths, and X/R ratios.

C. Short Circuit Study: Calculate the fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.
1. Show fault currents available at key points in the system down to a fault current of 7,000 A at 480 V and 208 V.
2. Include motor contributions in determining the momentary and interrupting ratings of the protective devices.
3. Primary Fault Level Assumptions: As indicated on drawings.

4. Report: Include all pertinent data used in calculations and for each device include:
    a. Device identification.
    b. Operating voltage.
    c. Protective device.
    d. Device rating.
    e. Calculated short circuit current, asymmetrical and symmetrical, and ground fault current.

D. Coordination Study: Perform an organized time-current analysis of each protective device in series from the individual device back to the primary source, under normal conditions, alternate operations, and emergency power conditions.
1. Graphically illustrate that adequate time separation exists between series devices, including upstream primary device, for emergency and essential electrical distribution systems above 0.1 seconds.
2. Plot the specific time-current characteristics of each protective device on log-log scales.
3. Organize plots so that all upstream devices are clearly depicted on one sheet.
4. Also show the following on curve plot sheets:
    a. Device identification.
    b. 3-phase and 1-phase ANSI damage curves for each transformer.
    c. No-damage, melting, and clearing curves for fuses.
    d. Cable damage curves.
    e. Transformer inrush points.
    f. Maximum short circuit cutoff point.
    g. Simple one-line diagram for the portion of the system that each curve plot illustrates.
    h. Software report for each curve plot, labeled for identification.

E. Analysis: Determine ratings and settings of protective devices to minimize damage caused by a fault and so that the protective device closest to the fault will open first.
1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
2. Identify any equipment that is underrated.
3. Identify specified protective devices will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor changes include different trip sizes in the same frame, time curve characteristics of induction relays, CT ranges, etc.
4. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve a change to the contract.
5. In all cases where adequate protection or coordination cannot be achieved at no extra cost, provide a discussion of alternatives and logical compromises for best achievable coordination.

F. Protective Device Rating and Setting Chart: Summarize in tabular format the required characteristics for each protective device based on the analysis; include:
1. Device identification.
2. Relay CT ratios, tap, time dial, and instantaneous pickup.
3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.

4. Fuse rating and type.
5. Ground fault pickup and time delay.
6. Input level and expected response time at two test points that are compatible with commonly available test equipment and the ratings of the protective device.
7. Highlight all devices that as furnished by Contractor will not achieve required protection.

1.7 QUALITY ASSURANCE

A. Study Preparer Qualifications: Electrical testing agency regularly engaged in short circuit and coordination studies, with at least 5 years experience in work of this type, and employing professional electrical engineer licensed in the State of Connecticut to perform the studies.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

C. Contractor Responsibility: Provide all project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, and actual circuit lengths.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "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. 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.

2.3 PROTECTIVE DEVICES

A. Provide protective devices of ratings and settings as required so that the protective device closest to the fault will open first.

B. In addition to requirements specified elsewhere, provide overcurrent protective devices having ratings and settings in accordance with results of this analysis.

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.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled.

3.2 FIELD QUALITY CONTROL

A. Provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the installed protective devices to conform to requirements determined by the coordination analysis.

B. Adjust installed protective devices having adjustable settings to conform to requirements determined by the coordination analysis.

C. Submit report showing final adjusted settings of all protective devices.

D. Results of the above shall be documented in writing and provided within the O&M manuals and to the CX agent as part of the closeout.

END OF SECTION

SECTION 260923

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. General Requirements
2. Lighting Contactors
3. Line Voltage Switches
4. Line Voltage Dimmer Switches
5. Switch Plates.
6. Line Voltage Occupancy/Vacancy Sensor Switches
7. Low Voltage Occupancy/Vacancy Sensors
8. Photocells
9. Room Controllers / Power Packs
10. Low Voltage Keypads / Switches.
11. UL 924 Bypass Relays
12. Lighting Control Relay Panels
13. Class 2 Conductors and Cables

B. Related Sections:
1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.
2. Section 26 05 19– Electrical Power Conductors and Cables.
3. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Product requirements for raceway and boxes for placement by this section.
4. Section 26 05 53 - Identification for Electrical Systems: Product requirements for electrical identification items for placement by this section.
5. Section 26 24 16 - Panelboards.
6. Section 26 27 26 - Wiring Devices: Product requirements for wiring devices for placement by this section.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contractors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks.
5. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
6. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
7. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
8. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
9. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2015.

B. 47 CFR 15 - Radio Frequency Devices; current edition.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.

G. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

H. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

I. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

J. IECC – International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 SYSTEM DESCRIPTION

A. IECC compliant lighting controls to control all interior and exterior lighting:
1. Standalone lighting controls in individual spaces consisting of some combination of occupancy sensors, vacancy sensors, photocells, power packs, low voltage switches and low voltage switches with dimming capability.
2. Standalone microprocessor based controllers with distributed switching control using self-contained individually mounted lighting relays. Provides multiple modes of operation incorporating vacancy sensors, photocells and low voltage control stations.
3. Lighting control relay panels to control lighting in corridors, large open areas, and site lighting. Incorporates microprocessor local and centralized control, communications modules, bus connected sensors and control stations and power supplies.

B. Refer to lighting control details and riser diagrams on the drawings for additional information.

C. Provide automatic shutoff for lighting inside building, where required. Control shutoff by method conforming to IECC.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall switches with actual installed door swings and sidelights.
3. Coordinate the placement of wall switch occupancy/vacancy sensors with actual installed door swings and sidelights.
4. Coordinate the placement of occupancy/vacancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
5. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.

6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:
1. Protect lighting control devices during construction.
2. Clean lighting control devices once final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Shop Drawings: Indicate dimensioned drawings of lighting control system components and accessories.
1. One Line Diagram: Indicating system configuration, panels, number and type of switches or devices.
2. Include typical wiring diagrams for each component.
3. Floor Plan Layout Drawings: Manufacturers symbols are acceptable, provided that symbology between engineer’s device legend and manufacturers symbols are cross-referenced.

C. Product Data: Submit manufacturer’s standard product data for each system component. This shall include, but not be limited to: ratings, configurations, dimensions, sensor coverage ranges, colors, service condition requirements, and installation features.

D. Manufacturer's Installation Instructions: Submit for each system component.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections and evidence that the control schemes identified herein and shown on the typical lighting control details are configured and operational as specified.
1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
2. Provide documentation addressing each room/area control scheme specified with a description of how the submitted system complies.

G. LEED Submittals: Provide manufacturers' or third-party certification of testing to and compliance with the California Department of Public Health (CDPH) Standard method v1.2-2017, that includes the following information:
1. The exposure scenario used to determine compliance.
2. The range of total VOCs after 14 days, measured as specified in the CDPH Standard Method v1.2:
3. 0.5 mg/m^3 or less;
4. Between 0.5 and 5.0 mg/m^3; or
5. 5.0 mg/m^3 or more
6. Laboratory accreditation under ISO/IEC 17025.
7. Claims of compliance for wet-applied products must state the amount applied in mass per surface area
8. Provide MSDS or other manufacturer documentation with disclosure of VOC content for all wet-applied products.
9. Complete "LEED Materials Documentation Sheet" with IEQc2 information for adhesives/sealants installed within the waterproofing membrane.

1.6 CLOSEOUT SUBMITTALS

A. See Division 01 - General Requirements

B. Project Record Documents: Record the following information:
1. Actual installed locations of components and settings for lighting control devices. Record circuiting and switching arrangements.
2. Wiring diagrams reflecting field-installed conditions with identified and numbered system components and devices.

C. Operation and Maintenance Data:
1. Submit replacement parts numbers.
2. Submit manufacturer's published installation instructions and operating instructions.
3. Recommended renewal parts list.
4. Detailed information on device programming and setup.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience. Company shall provide 24/7 telephone support by qualified technicians.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

C. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.

D. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the system provider, as required to ensure proper system operation and maintainability.

E. Performance Requirements: Shall provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.

F. Performance Testing Requirements
1. Manufacturer shall 100% test all equipment prior to shipment. Sample testing is not acceptable.

G. Code Requirements
1. System Control Unit and System Field Devices shall be UL listed and certified.
2. All system components shall be FCC / IC compliant.
3. All system components shall be installed in compliance with National Electrical Codes.
4. Building Codes: All units shall be installed in compliance with applicable, local building codes.

1.8 PRE-INSTALLATION MEETINGS

A. See Division 01 - General Requirements.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. See Division 01 - General Requirements.

B. Accept components on site in manufacturer's packaging. Inspect for damage.

C. Protect components by storing in manufacturer's containers indoor protected from weather.

1.10 WARRANTY

A. See Division 01 - General Requirements.

B. Furnish five year manufacturer warranty for all components.

1.11 EXTRA MATERIALS

A. See Division 01 - General Requirements Furnish two of each switch type.

B. Furnish four of each occupancy/vacancy sensor type.

C. Furnish two of each photocell type.

D. Furnish two of each power pack type.

E. Furnish two room controllers.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL DEVICES – GENERAL REQUIREMENTS

A. Manufacturers:
1. nLight
2. Hubbell
3. Douglas
4. Substitutions: See Division 01 – General Requirements.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

D. Products for Switching of Electronic Ballasts/Drivers: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

E. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

F. Refer to lighting control details on drawings for additional requirements and product specifications.

G. LEED Requirements:
1. For field applications that are inside the weatherproofing membrane: Adhesives/sealants must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario. The default scenario is the private office scenario.
2. All adhesives/sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.

2.2 LINE VOLTAGE SWITCHES

A. Manufacturers:
1. Hubbell Incorporated
2. Leviton Manufacturing Co., Inc.
3. Pass and Seymour/Legrand
4. Substitutions: Division 01 - General Requirements.

B. Line Voltage Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
2. Body and Handle finish: Color selection by Architect.

C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

E. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

G. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.

H. Locking Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.3 LINE VOLTAGE DIMMER SWITCHES

A. Manufacturers:
1. Leviton Manufacturing Company, Inc.
2. Lutron Electronics Company, Inc; Maestro Series
3. Pass & Seymour, a brand of Legrand North America, Inc.
4. Substitutions: See Division 01 - General Requirements.

B. Line Voltage Dimmer Switches - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
1. Body and Control finish: Color selection by Architect.

C. Control: Slide control type with separate on/off switch.

D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:
1. Incandescent: 600 VA.
2. Magnetic Low-Voltage: 600 VA.
3. Electronic Low-Voltage: 400 VA.
4. Fluorescent: 600 VA.

E. Provide locator light, illuminated with load off.

F. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

G. Refer to plans and lighting fixture schedule for dimming driver/ballast requirements.

2.4 SWITCH PLATES

A. Manufacturers:
1. Hubbell Incorporated
2. Leviton Manufacturing Co., Inc.
3. Pass and Seymour/Legrand
4. Substitutions: Division 01 - General Requirements.
   a. Where low voltage keypads / switches or line voltage sensor switches are shown, provide switch plate by same manufacturer.

B. Product Description: Specification Grade.
1. Material:
   a. Stainless Steel in finished spaces.
   b. Stainless steel in back of house spaces.
   c. Galvanized steel in wet or damp back of house spaces, mechanical; rooms and electrical rooms.

2.5 LINE VOLTAGE OCCUPANCY/VACANCY SENSOR SWITCHES

A. Manufacturers: See Paragraph 2.1(A)

B. Product Description: Provide wall switch style occupancy/vacancy sensor capable of turning lights OFF when the space becomes unoccupied and ON when the space becomes re-occupied. Provide with 0-10V dimming capabilities and/or integral daylight control, where indicated on the drawings. Refer to drawings for occupancy or vacancy mode setting.
   1. Material:
      a. Stainless steel in finished and back of house spaces.
      b. Galvanized steel in damp back of house spaces, mechanical; rooms and electrical rooms.

C. Sensor Switch Requirements:
   1. Sensor switch shall be line voltage @ 120/277 VAC, rated for 20A.
   2. Sensor technology shall be dual technology: PIR and ultrasonic.
   3. Sensor shall have field of view of 180 degrees.
   4. Sensor switch shall be capable of operating with LED.
   5. Sensor switch shall be set to:
      a. Auto-ON, Auto-OFF mode (Occupancy Sensor)
      b. Manual-ON, Auto-OFF mode (Vacancy Sensor)
      c. Dipswitch selectable to toggle between occupancy and vacancy mode.
   6. Sensor shall be capable of turning lights OFF after 20 minutes of inactivity. Switch shall also have 10 and 20 minute overrides.
   7. Provide device capable of accepting a 2-wire (hot and neutral) input plus ground.
   8. Sensor switch shall be capable of operating in conjunction with a 3-way switch per manufacturers requirements, where indicated on drawings.
   9. Provide with integral daylight harvesting control: 10-500 foot-candle override range where indicated.

2.6 LOW VOLTAGE OCCUPANCY/VACANCY SENSORS

A. Manufacturers: See Paragraph 2.1(A)

B. Product Description: Factory-assembled commercial grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated. Mounting as indicated on floor plans.

C. Sensor Requirements:
   1. Sensor Technology:
      a. Sensor shall be Dual Technology, unless otherwise noted on drawings. Available sensor technologies:
         1) Passive Infrared/Ultrasonic Dual Technology Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
         2) Passive Infrared/Acoustic Dual Technology Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.
   2. Sensor shall be set to:
      a. Auto-ON, Auto-OFF mode (Occupancy Sensor)
      b. Manual-ON, Auto-OFF mode (Vacancy Sensor)
      c. Dipswitch selectable to toggle between occupancy and vacancy mode.

3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
4. Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
5. Passive Infrared Lens Field of View: Field customizable to block motion detection in selected areas.
6. Sensor shall be capable of turning lights OFF after 20 minutes of inactivity. Switch shall also adjustable overrides.
7. Sensitivity: Field adjustable.
8. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
9. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.
10. Coverage:
    a. Small Space (< 500 Sq Ft): 500 square feet minimum
    b. Medium Space (500-1000 Sq Ft): 1,000 square feet minimum
    c. Large Space (>1000 Sq Ft): 2,000 square feet minimum. Multiple sensors where shown on the plans.
11. Furnish with power pack or room controller by same manufacturer.
    a. Provide for zone control and maximum number of sensors connected to power pack per manufacturer's requirements.
    b. Provide room controller with functions and quantity of zones as indicated on drawings and as required per manufacturer. Refer to Paragraph 2.9 for additional information.
12. Operation: Silent.

D. Room Sensor Type: As indicated on Drawings.

E. Corridor and Hallway Sensors:
1. Capable of detecting major motion with a long, narrow pattern designed for corridor and aisle sensing. Refer to lighting control details for product specification.

F. High Bay areas: For areas with ceilings more than 15 feet above finished floor, provide high-bay ceiling mounted occupancy sensor. Refer to lighting control details for product specification.

2.7 PHOTOCELLS

A. Manufacturers: See Paragraph 2.1(A)

B. Product Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls. Sensor mounted as indicated on Drawings with separate control-calibration module. Control unit powered by 24 VAC.

C. Control-Calibration Module: Furnish with the following:
1. Capable of being switched between multiple measurement ranges.
2. Separate trip points for high and low response settings.
3. Three-minute time delay between switching outputs to avoid nuisance tripping.

D. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.

1. Sensor Type: Photodiode with diffusing lens
2. Sensor Range:
   a. Indoor Photo Sensors: 5 to 100 footcandles (53.8 to 1,080 lx).
   b. Outdoor Photo Sensors: 5 to 250 footcandles (53.8 to 2690 lx).
   c. Atrium Photo Sensors: 200 to 2,500 footcandles (2150 to 2,6910 lx).
   d. Skylight Photo Sensors: 1,000 to 6,000 footcandles (10,760 to 64,580 lx).
   e. Open Loop Photo Sensors: 3 to 6,000 footcandles (32.3 to 64,580 lx).
3. Finish: White unless otherwise indicated.

E. Standalone Dimming Photo Sensors: Photo sensor units with integral 0-10V controller compatible with specified dimming drivers/ballasts, for direct continuous dimming of up to 50 drivers/ballasts.

F. Daylighting Control Switching Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors, for switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.

2.8 ROOM CONTROLLERS / POWER PACKS

A. Manufacturers: See Paragraph 2.1(A)

B. Refer to lighting control details on drawings for types, configurations, performance requirements, and additional information.

C. Description: Integrated lighting, dimming, and equipment switching control system for mounting in a concealed space, enclosure shall be plenum rated. Provide pre-configured lighting controller(s), with capabilities for manual setup, and software setup through programming port, configured as a standalone controller.
1. Room Controllers.
2. Power Packs.

D. Dimmable Load Types: 16A per channel at 100 to 277VAC, 50/60 Hz:
1. 0 – 10V LED drivers.

E. Switched Load Types:
1. Fluorescent ballast.
2. Incandescent.

F. Magnetic low voltage.
1. Electronic low voltage.
2. LED

G. General Requirements:
1. Power Packs:
   a. Main Power: 100 – 277 VAC, 50/60 Hz.
   b. Input/Output (Refer to Drawings and Details for Input/Output Applicable to Project):
      1) Line Power Inputs: 1.
      2) Switch Channel Outputs: 1 or 2.
      3) 0 – 10V Dimmer Outputs: 1 - Class 1 or Class 2.
      4) Auxiliary Relay for Interface with Other Systems.
      5) Auxiliary Inputs: Hold On/Hold Off as specified.

c. Enclosure: Plenum rated, surface-mounted industrial control enclosure mounts directly to electrical junction box.

2. Room Controllers:
   a. Main Power: 100 – 277 VAC, 50/60 Hz.
   b. Input/Output (Refer to Drawings and Details for Input/Output Applicable to Project):
      1) Line Power Inputs: 1.
      2) Switch Channel Outputs: As Indicated on Drawings.
      3) 0 – 10V Dimmer Outputs: As Indicated on Drawings. Class 1 or Class 2.
      4) Device Bussing, Provide control bussing for the following:
         a) Low Voltage Keypads / Switches
         b) Photocells / Daylight Sensors
         c) Occupancy / Vacancy Sensors
         d) Wiring: CAT X, Digital, or per manufacturers requirements.
      5) Auxiliary Relay for Interface with Other Systems.
      6) Auxiliary Inputs: Hold On/Hold Off as specified.
   c. Enclosure: Plenum rated surface-mounted industrial control enclosure.
   d. Control Processor:
      1) Integrates sensors and other low voltage controls, devices, and subsystems through multiple control interfaces with control network. Refer to drawings for functions and operation required by project.

2.9 LOW VOLTAGE KEYPADS / SWITCHES

A. Provide low voltage keypads / switches with configuration, functionality and operation as indicated on drawings.

B. General Requirements:
   1. Custom engravable buttons/switches, refer to drawings for labeling. Refer to Paragraph C below for additional requirements.
   2. Quantity and function as indicated on drawings.
   3. LED indicators, as shown on drawings.
   4. Configured to fit in standard gang boxes.
   5. Color: By Architect

C. Labeling:
   1. Provide factory engraved labels for all low voltage keypads / switches buttons.
   2. Refer to lighting control details on drawings for suggested labeling of lighting control equipment. Coordinate naming of scenes/control zones with the Owner. Provide a worksheet listing remote keypad controls, room numbers used in, associated control details. Submit labeling requests and locations to the Owner.
   3. Do not order labels until Owner coordination is complete.

D. Lighting keypad shall be provided by the same manufacturer as the lighting control system.

2.10 UL 924 BYPASS RELAYS

A. General Requirements:
1. Refer to drawings and details for required functions.
2. The UL 924 Bypass Relay shall automatically illuminate connected emergency loads upon utility power interruption, regardless of room switch position. (NEC Article 700)
3. The UL 924 Bypass Relay shall include an automatic diagnostic, which is initiated when the room switch is turned off. This test procedure will turn the emergency luminaires on for at least 2 seconds, indicating that an emergency power source is available & that the device, ballast, & lamp are all functioning correctly.
4. Automatic diagnostic shall be approved to meet periodic testing requirements (NEC Article 700 NFPA 101 Chapter 7)
5. Local room switch, dimmer or lighting keypad shall turn both regular & emergency luminaires on at the same time (no dedicated emergency room switch required).
6. The UL 924 Bypass Relay shall include a dry contact for 0-10V override during utility power interruption, where indicated on drawings and details.
7. The UL 924 Bypass Relay shall have a minimum load rating of 20 Amps at 120V or 277V, general use 20 Amps.
8. The UL 924 Bypass Relay shall accept 120V & 277V 60 Hz Input & Output (voltage tolerance +/- 15%).
9. The UL 924 Bypass Relay shall include emergency power and regular power indicator LED’s and a manual test switch which are visible to room occupants when installed flush. (UL924 Section 29)
10. Load contacts shall be able to withstand 10 direct shorts while connected to 20 Amp breaker without permanent damage.
11. The UL 924 Bypass Relay shall not generate any objectionable electrical or mechanical noise.
12. The UL 924 Bypass Relay shall mount inside a 4-11/16” junction box with an extension & single gang plaster ring.
13. The UL 924 Bypass Relay shall be installed flush to the ceiling or above ceiling adjacent to load controlled, such that test switch & LED’s are in plain view of room occupants as required by some local electrical codes.
14. The UL 924 Bypass Relay shall have UL94-V0 or UL94-5VA flame rating & be approved for installation above the suspended ceiling

2.11 LIGHTING RELAY PANELS

A. Manufacturers: See Paragraph 2.1(A)

B. Product Description: Standalone relay panel with quantity of relays as indicated on drawings. Standalone panel shall utilize a digital controller with LCD screen and numerical keypad.

C. All components are to be supplied by the same manufacturer. The manufacturer shall be a supplier of this type of equipment for over 5 years.

D. Relay Panel shall come pre-assembled complete with Relays, Transformer & Timeclock.

E. Relays mounted in the lighting control panels shall be full load relays suitable for all types of lamp loads up to 20 Amperes. Relays shall be mechanically latching and must have a physical ON/OFF override built into the relay.

F. Time Controls shall be a 365 Day Astronomical Timer for switching, 2-Wire Relays. Programming shall be accomplished by entering data on a membrane key pad with an LCD graphic display. Any output shall be time, astro, photo-controlled or combination photo/time or astro/time controlled. There shall be available up to 500 events per week and 32 holiday programs. The controllers memory and time are not lost when power fails. Programs are held indefinitely and time is held for 72 hours.

G. Provide with inputs for each relay for manual override and programmable control of associated relays or groups of relays.

H. Provide with “BLINK” warning to blink the lights prior to expiration (off control) of a relay or groups of relays via time schedule.
1. When manual override control is activated relay or relay group shall remain on for up to two hours (programmable).
2. Relay or groups of relays shall sweep off every two hours until next time scheduled event.

I. Provide manual override low-voltage switches by same manufacturer in locations indicated on drawings.

J. Panel shall be capable of connecting to the building management system via BACNET interface.

K. Panel shall be capable of connecting to the fire alarm system to force all lighting fed through relay panel to 100% brightness.

2.12 CLASS 2 CONDUCTORS AND CABLES

A. General Requirements:
1. Line Voltage Wiring: Comply with requirements of Division 26 Section "Electrical Power Conductors and Cables".
2. Class 2 Low-Voltage Cable:
a. Provide plenum-rated cable.
b. UTP Cable: CAT 5, CAT 6, or as required by manufacturer:
1) Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
2) All cabling shall meet or exceed Commercial Building Telecommunications Cabling Standard ANSI/TIA/EIA 568-C.2
3) Cabling shall use 23AWG minimum conductors.
4) Pulling tension: The cable pulling tension shall not exceed 25 ft/lbs as indicated in TIA/EIA-568-A.
c. Control Cable:
1) Stranded copper cable, Type CMP.
a) Multiple-Conductor.
b) Twisted Pair.
c) Shielded Twisted Pair
d) Minimum AWG: Per manufacturer requirements, as shown on drawings and details.

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification:
1. Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instruction.
2. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
3. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
4. Verify that final surface finishes are complete, including painting.
5. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
6. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
7. Verify that conditions are satisfactory for installation prior to starting work.

B. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to System Field Devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire). The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

B. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards, unless otherwise indicated. Install per manufacturer's instructions.

C. Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.

D. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

E. Install wiring in accordance with Section 260519 and paragraph 2.13.

F. Use only properly color coded, stranded wire. Install wire sizes as indicated on Drawings. Install wire in conduit in accordance with Section 260533 and paragraph 2.13.

G. Mount relay panel as indicated on Drawings. Wire numbered relays in panel to control power to each load.

H. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

I. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.

J. Label each low voltage wire with relay number at each switch or sensor. Refer to Section 260553.

K. Coordinate locations of outlet boxes provided under Section 260533 as required for installation of lighting control devices provided under this section.

L. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.

M. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.

N. Prior to setting scenes or zones dependent on furniture placement, whiteboard locations, projection screen locations, lectern locations or similar, coordinate with the Owner, Architect and red-lined furniture plans. Make all required adjustments during construction.

O. Systems Integration:
   1. Equipment Integration Meeting:
      a. Facility Representative to coordinate meeting between Facility Representative, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures prior to system startup

P. Systems Coordination:
   1. System Coordination Meeting:
      a. Contractor to coordinate meeting between Facility Representative, and Lighting Control System Manufacturer to discuss programming, including but not limited to:
         1) Zone and scene settings including dimming levels for all spaces.
         2) Time schedules for timed controlled lighting.
         3) Blink warning scheduling.
      b. A minimum of four weeks prior to the system coordination meeting the contractor shall distribute programming worksheets to the owner covering all of the items listed above for all spaces.

Q. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

R. Install lighting control devices plumb and level, and held securely in place.

S. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

T. Identify lighting control devices in accordance with Section 260553.

U. Unless otherwise indicated, install power packs/room controllers for lighting control devices within the same space above accessible ceiling or above access panel in inaccessible ceiling.

V. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

3.4 SENSOR INSTALLATION:

A. Adjust sensitivity to cover area installed

B. Set time delay on sensors that are connect to the lighting control system to the minimum. Time delay to off shall be set to no longer than 20 minutes.

C. Provide vacancy sensor configurations as indicated on drawings.

D. Install sensors on vibration free stable surface.

E. Install atrium and skylight light sensor facing toward window or skylight.

F. Install interior light sensor in ceiling facing the floor.

G. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage.

H. Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.

I. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors away from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

J. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on sensor lenses to block undesired motion detection.

K. Outdoor Photo Sensor Control Locations:
   1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
   2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

3. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.
4. Unless otherwise indicated, set outdoor photo sensor for dusk-to-dawn operation. Lighting shall turn on at dusk / off at dawn.

L. Daylighting Control Photo Sensor Locations:
1. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize control and avoid conflicts or problems affecting proper detection of light levels.
2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.
4. Refer to drawings and details for maintained light level settings.

3.5 MANUFACTURER'S FIELD SERVICES

A. Division 01 - General Requirements.

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 field tests and inspections with the assistance of a factory-authorized service representative:
1. Operational Test: After installing wall stations 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.
3. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
4. Test outdoor photo controls to verify proper operation, including time delays where applicable. Record test results in written report to be included with submittals.
5. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
6. Adjust relay panel settings to achieve desired operation schedule as indicated or as directed by Architect. Record settings and as-built relay panel schedules in written report, to be included with submittals.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

3.6 FIELD QUALITY CONTROL

A. Division 01 - General Requirements.

B. Inspect each lighting control device for damage and defects.

C. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.7 ADJUSTING

A. Division 01 - General Requirements.

B. Test contactors and switches after installation to confirm proper operation.

C. Confirm correct loads are recorded on directory card in each panel.

D. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.8 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.9 COMMISSIONING

A. Division 01 - General Requirements.

3.10 DEMONSTRATION

A. Division 01 - General Requirements.

B. Demonstrate proper operation of lighting control devices to Architect and Owner, and correct deficiencies or make adjustments as directed.

C. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.
   4. Instructor: Qualified manufacturer’s representative familiar with the project and with sufficient knowledge of the installed lighting control devices.

END OF SECTION

SECTION 262200

LOW-VOLTAGE DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General purpose transformers.

B. Shielded transformers.

1.2 RELATED REQUIREMENTS

A. Division 01 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260534 - Conduit: Flexible conduit connections.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 262416 - Panelboards.

1.3 REFERENCE STANDARDS

A. CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.

B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.

C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; 2013.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.

F. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with placement of support framing and anchors required for mounting of transformers.

2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

3. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 – General Requirements.

B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
1. Vibration Isolators: Include attachment method and rated load and deflection.
2. K-factor Rated Transformers: Include K-factor ratings.
3. Buck-boost Transformers: Include voltage selection tables and wiring diagrams for autotransformer configurations.

C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.
1. Small Power Centers: Include panel arrangements.

D. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Maintenance Data: Include recommended maintenance procedures and intervals.

H. Project Record Documents: Record actual locations of transformers.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
   1. Greater than 10 kVA: 104 degrees F (40 degrees C) maximum.
   2. Less than 10 kVA: 77 degrees F (25 degrees C) maximum.

1.9 WARRANTY

A. See Division 01 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Eaton Corporation.

B. General Electric Company.

C. Schneider Electric; Square D Products.

D. Siemens Industry, Inc.

E. Substitutions: See Division 01 - Product Requirements.

F. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
   1. Altitude: Less than 3,300 feet (1,000 m).
   2. Ambient Temperature:
      a. Greater than 10 kVA: Not exceeding 104 degrees F (40 degrees C).
      b. Less than 10 kVA: Not exceeding 77 degrees F (25 degrees C).

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Primary Voltage: 480 volts delta, 3 phase.

C. Secondary Voltage: 208Y/120 volts, 3 phase.

D. Insulation System and Allowable Average Winding Temperature Rise:
   1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
   2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

E. Coil Conductors: Continuous copper windings with terminations brazed or welded.

F. Winding Taps:
   1. Less than 3 kVA: None.
   2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
   3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

G. Energy Efficiency:
1. Comply with CFR 431, Subpart K.
2. Comply with the Department of Energy 2016 Efficiency Standards.

H. Sound Levels: Standard sound levels complying with NEMA ST 20.
1. 0-9 kVA: 40 dB.
2. 10-50 kVA: 45 dB.
3. 51-150 kVA: 50 dB.
4. 151-300 kVA: 55 dB.
5. 301-500 kVA: 60 dB.
6. 501-700 kVA: 62 dB.
7. 701-1000 kVA: 64 dB.

I. Mounting Provisions:
1. Less than 15 kVA: Suitable for wall mounting.
2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
3. Larger than 75 kVA: Suitable for floor mounting.

J. Transformer Enclosure: Comply with NEMA ST 20.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor clean, dry locations: Type 1.
   b. Outdoor locations: Type 3R.
2. Construction: Steel.
   a. Less than 15 kVA: Totally enclosed, non-ventilated.
   b. 15 kVA and Larger: Ventilated.
3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.

K. Accessories:
1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.4 SHIELDED TRANSFORMERS

A. Description: Self-cooled, two winding, shielded isolation transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Primary Voltage: 480 volts delta, 3 phase.

C. Secondary Voltage: 208Y/120 volts, 3 phase.

D. Insulation System and Allowable Average Winding Temperature Rise:
1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

E. Coil Conductors: Continuous copper windings with terminations brazed or welded.

F. Winding Taps:
1. Less than 3 kVA: None.
2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

G. Energy Efficiency:
1. Comply with CFR 431, Subpart K.
2. Comply with the Department of Energy 2016 Efficiency Standards.

H. Sound Levels: Standard sound levels complying with NEMA ST 20.
1. 0-9 kVA: 40 dB.
2. 10-50 kVA: 45 dB.
3. 51-150 kVA: 50 dB.
4. 151-300 kVA: 55 dB.
5. 301-500 kVA: 60 dB.
6. 501-700 kVA: 62 dB.
7. 701-1000 kVA: 64 dB.

I. Winding Shield: Electrostatic, with separate insulated grounding connection.

J. Mounting Provisions:
1. Less than 15 kVA: Suitable for wall mounting.
2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
3. Larger than 75 kVA: Suitable for floor mounting.

K. Transformer Enclosure: Comply with NEMA ST 20.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor clean, dry locations: Type 1.
   b. Outdoor locations: Type 3R.
2. Construction: Steel.
   a. Less than 15 kVA: Totally enclosed, non-ventilated.
   b. 15 kVA and Larger: Ventilated.
3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.

L. Accessories:
1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.5 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that suitable concrete pads, support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 260534, 2 feet (600 mm) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

G. Mount floor-mounted transformers on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Division 03.

H. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.

I. Mount trapeze-mounted transformers using suitable metal framing as recommended by the manufacturer. See Section 260529 for material requirements.

J. Provide seismic restraints where required by local codes.

K. Provide grounding and bonding in accordance with Section 260526.

L. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

M. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.

N. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.

O. Identify transformers in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Division 01 – General Requirements

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.
   1. 167 kVA single phase, 500 kVA three phase and smaller:
      a. Perform turns ratio tests at all tap positions.
   2. Larger than 167 kVA single phase and 500 kVA three phase:
      a. Verify that control and alarm settings on temperature indicators are as specified.
      b. Perform excitation-current tests on each phase.
      c. Measure the resistance of each winding at each tap connection.
      d. Perform an applied voltage test on all high- and low-voltage windings-to-ground.

3.4 ADJUSTING

A. See Division 01 – General Requirements.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

C. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. See Division 01 – General Requirements.

B. Clean dirt and debris from transformer components according to manufacturer's instructions.

C. Repair scratched or marred exterior surfaces to match original factory finish.

3.6 PROTECTION

A. Protect installed transformers from subsequent construction operations.

END OF SECTION

SECTION 262413

SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.2 RELATED REQUIREMENTS

A. Division 01 - General Requirements

B. Division 03 - Concrete

C. Section 260400 – General Conditions for Electrical Trades

D. Section 260526 - Grounding and Bonding for Electrical Systems

E. Section 260553 - Identification for Electrical Systems

F. Section 260573 – Overcurrent Protective Device Coordination Study

G. Section 262813 – Fuses

H. Section 262826 – Enclosed Transfer Switches

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Current Edition, Including All Revisions.

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; Current Edition, Including All Revisions.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; Current Edition, Including All Revisions.

D. NECA 400 - Standard for Installing and Maintaining Switchboards; Current Edition, Including All Revisions.

E. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); Current Edition, Including All Revisions.

F. NEMA PB 2 - Deadfront Distribution Switchboards; Current Edition, Including All Revisions.

G. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; Current Edition, Including All Revisions.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition, Including All Revisions.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

L. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

M. UL 891 - Switchboards; Current Edition, Including All Revisions.

N. UL 977 - Fused Power-Circuit Devices; Current Edition, Including All Revisions.

O. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:
1. Coordinate with Electric Utility Company and provide switchboards in compliance with Utility Company requirements and with suitable provisions for electrical service and utility metering, where applicable.
2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
3. Obtain Utility Company approval of switchboard prior to fabrication.
4. Pre-installation Meeting: Convene with Utility Company representative a minimum of two weeks prior to commencing work of this section to review requirements.
5. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and front & side elevation views of switchboards and adjacent equipment with overall dimensions shown and all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.
   3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   4. Include documentation of listed series ratings upon request.
   5. Include documentation demonstrating selective coordination upon request.

D. Service Entrance Switchboards: Include documentation of Utility Company approval of switchboard.

E. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 2 as production tests.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Field Quality Control Test Reports.

H. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.

I. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Division 01 - General Requirements.
   2. Enclosure Keys: Two of each different key.
   3. Electronic Trip Circuit Breakers: Provide one portable test set.
   4. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

B. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Switchboards
1. Basis of Design: Eaton Corporation
2. Schneider Electric; Square D Products
3. General Electric Company
4. Substitutions: See Division 01 - General Requirements.

B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

C. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Front-Connected Switchboards:
1. Main Device(s): Individually-mounted.
2. Feeder Devices: Panel/group-mounted.
3. Arrangement: Front accessible only (not rear accessible), front aligned.
4. Gutter Access: Bolted covers.
5. Arcflash Reduction Maintenance System (ARMS).
6. Pull Section: Size as indicated on Drawings, depth and height to match switchboard. Arrange as indicated on Drawings.
7. Integral enclosed transfer switch where indicated on drawings.
8. Align sections at front only.

E. Service Entrance Switchboards:
1. Listed and labeled as suitable for use as service equipment according to UL 869A.
2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
3. Comply with Utility Company requirements for electrical service.
4. Utility Metering Provisions: Provide separate barriered compartment complying with Utility Company requirements where indicated or where required by Utility Company. Include hinged sealable door and provisions for Utility Company current transformers (CTs), potential transformers (PTs), or potential taps as required.

F. Service Conditions:
1. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
a. Altitude: Less than 2000 feet.
b. Ambient Temperature: Between 50 degrees F and 95 degrees F.

G. Short Circuit Current Rating:
1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 260573.

H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

I. Bussing: Sized in accordance with UL 891 temperature rise requirements.
1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

4. Provide factory labeled holes in busbars at end of lineup (opposite end from main device) for future bus taps. Label with word “TAP” and provide instructions for use with switchboard documentation.
5. Phase and Neutral Bus Material: Silver Plated Copper.
6. Ground Bus Material: Silver Plated Copper.

J. Conductor Terminations: Suitable for use with the conductors to be installed.
1. Line Conductor Terminations:
   a. Main and Neutral Lug Material: Silver Plated Copper, suitable for terminating aluminum or copper conductors.
   b. Main and Neutral Lug Type: Mechanical.
2. Load Conductor Terminations:
   a. Lug Material: Silver Plated Copper, suitable for terminating aluminum or copper conductors.
   b. Lug Type:
      1) Provide mechanical lugs unless otherwise indicated.
      2) Provide compression lugs where indicated.

K. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.
2. Finish: Manufacturer's standard unless otherwise indicated.

L. Future Provisions:
1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.
3. Where designated spaces for future device provisions are not indicated, include provisions for minimum of six device(s) rated at ten percent of rating of switchboard main or incoming feed.
4. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.

M. Surge Protective Device:
1. Product Description: IEEE C62.41, factory-mounted surge protective device, selected to meet requirements for high exposure (200,000A) and to coordinate with system circuit voltage. integral type 1 surge protection at 480vY 3 phase with L-N=1200 L-G=1200 N-G=1200 and L-L 2000
2. Minimum surge current rating per phase: 320 kA.
3. Surge Protective device module shall be integral to switchboard and shall be fused.

N. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
   a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
   b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.

3. Furnish monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

O. All circuit breakers rated 1200 amps and above shall have arcflash reduction maintenance system (ARMS). Provide the following:

1. Arcflash Reduction Maintenance System Switch.
   a. Provide a maintenance OFF ON selector switch on the compartment door to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity.
   b. Provide a lock feature for the ARMS switch so that it may be locked in either the OFF or ON maintenance mode position.
   c. Provide a blue LED indicating light to indicate trip unit is in the ARMS mode.

P. Phase Failure Relay:

1. Provide integral phase failure relays within switchboard.

Q. Instrumentation:

1. Provide power metering equal to Eaton Power Xpert series power meter with display. Device shall be panel mounted in the switchboard. Devices by others will be considered providing all the following specifications are met.
2. The Power Meter shall be equipped with a two (2)-line by sixteen (16)-character LCD display for electrical circuit information.
3. The information displayed by the Power Meter shall include the following quantities:
   a. Current, per-phase
   b. Volts, phase-to-phase & phase-neutral
   c. Real Power (kW), three-phase total
   d. Reactive Power (kVAR), three phase total
   e. Apparent Power (kVA), three phase total
   f. Power Factor, true, per-phase & three-phase total
   g. Frequency
   h. Current Demand, per phase and neutral, present and peak
   i. Real Power Demand (kWd), three phase total, present and peak
   j. Reactive Power Demand (kVARd), three phase total, present and peak
   k. Apparent Power Demand (kVAd), three phase total, present and peak
   l. Real Energy (kWh), three phase total
   m. Reactive Energy (kVARh), three phase total
   n. Apparent Energy (kVAh), three phase total
   o. Energy Accumulation Modes, signed, absolute, energy in, energy out
   p. Watt-hour KYZ Pulse Initiator Output
   q. Total Harmonic Distortion, Voltage
   r. Total Harmonic Distortion, Current
   s. Date/Time Stamping.
4. Communications port for Power Monitoring Systems communications and Modbus RTU communications.
5. The Power Meter shall be accurate to .25% for voltage and current sensing, .50% for power, energy, & demand sensing, and 1% for power factor sensing.
6. All information stored in the Power Meter shall be remotely accessible through data communications.

7. The Power Meter shall be UL Listed, rated for an operating temperature range of 0C to 55C and have an overcurrent withstand rating of 500 amps for 1 second.
8. The Power Meter metering inputs shall utilize industry standard current transformers (5A secondary CT's), have VT inputs for direct connection of VT leads to up to 600V, and adhere to UL standard 508 for dielectric voltage-withstand.
9. Each Circuit Monitor shall have built-in data communications to allow multipoint communication to multiple computer workstations, programmable controllers, and other host devices, at a minimum data rate of 9600 baud.
10. The data communications shall be optically isolated to provide reliable operation.
11. Power meter shall include a communications interconnection interface with the Building Management System (BMS). Coordinate interconnection requirements with the BMS provider. Available protocols:
    a. Modbus.
    b. Ion.
    c. DNP3.
    d. IEC 61850.
    e. HTTP.
    f. FTP.
    g. SNMP.
    h. DPWS.
    i. RSTP.
    j. NTP.
    k. SNTP.
    l. GPS.

R. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
1. Interrupting Capacity:
    a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
    b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated. Series rating not allowed.
2. Main circuit breakers in all switchboards shall have Long time, Short time, Instantaneous and ground fault protection (LSIG) functions. These functions shall similar to those functions found on an Eaton Magnum or Power Defense circuit breaker. Circuit breaker shall have arcflash reduction maintenance setting (ARMS) system. Provide the following;
    a. Arcflash Reduction Maintenance System Switch (ARMS)
        1) For the main circuit breaker above 1200 amps, provide a maintenance OFF ON selector switch on the compartment door to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity.

2) Provide a lock feature for the ARMS switch so that it may be locked in either the OFF or ON maintenance mode position.
3) Provide a blue LED indicating light to indicate trip unit is in the ARMS mode.

3. Molded Case Circuit Breakers:
   a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings and panel schedules.
      1) Provide thermal magnetic circuit breakers unless otherwise indicated.
      2) Provide electronic trip circuit breakers where indicated on drawings and panel schedules.
   b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
      1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
      2) Provide interchangeable trip units for circuit breaker frame sizes 125A and above.
   c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units for circuit breaker frame sizes 225 amperes and higher or where indicated on the drawings and panel schedules.
      1) Provide the following field-adjustable trip response settings:
         a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
         b) Long time delay.
         c) Short time pickup and delay.
         d) Instantaneous pickup.
         e) Ground fault pickup and delay where ground fault protection is indicated.
   d. Provide the following circuit breaker types where indicated:
      1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.
      2) Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
   e. Provide the following features and accessories where indicated or where required to complete installation:
      1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
      2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
      3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
      4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.

5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.4 SOURCE QUALITY CONTROL

A. See Division 01 – General Requirements.

B. Factory test switchboards according to NEMA PB 2, including the following production tests on each switchboard assembly or component:
1. Dielectric tests.
2. Mechanical operation tests.
3. Grounding of instrument transformer cases test.
4. Electrical operation and control wiring tests, including polarity and sequence tests.
5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 6 inches between switchboard and wall.

E. Provide required support and attachment components in accordance with Section 260529.

F. Install switchboards plumb and level.

G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Division 03 - Concrete.

H. Provide grounding and bonding in accordance with Section 260526.

I. Install all field-installed devices, components, and accessories.

J. Provide fuses complying with Section 262813 for fusible switches as indicated.

K. Install identification in accordance with Section 260553.
   1. Labeling & Identification:
      a. Indicate the maximum available fault current at the equipment, including the date the fault current calculation was performed. Label shall include warning for “Arc Flash Hazard” and requirement for “PPE Protection”.
      b. Indicate locations of sources and feeders for all services to the building (generator and fire pump).

L. Installation of ARMS maintenance lockable selector switch and blue indicating light onto compartment door of the main circuit breaker. Installation of the IO module and the IFE module in accordance with manufactures recommendations.
   1. Set point for the ARMS instantaneous is based on the results of the Overcurrent Protective Device Coordination Study.

M. Install breaker circuit directory.

N. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

O. Provide filler plates to cover unused spaces in switchboards.

3.3 FIELD QUALITY CONTROL

A. See Division 01 - General Requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

E. Inspect and test in accordance with NETA ATS, except Section 4.

F. Perform inspections and tests listed in NETA ATS, Section 7.1.

G. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

H. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 225 amperes. Tests listed as optional are not required.
   1. Perform insulation-resistance tests on all control wiring with respect to ground.
   2. Test functions of the trip unit by means of secondary injection.

I. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 260573.

K. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

L. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10.

M. Test shunt trips to verify proper operation.

N. Correct deficiencies and replace damaged or defective switchboards or associated components.

O. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.5 CLEANING

A. See Division 01 – General Requirements.

B. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

C. Repair scratched or marred surfaces to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Division 01 – General Requirements.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchboard and associated devices.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

3.7 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes distribution and branch circuit panelboards.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 53 - Identification for Electrical Systems.
3. Section 26 05 73 – Overcurrent Protective Device Coordination Study.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
6. NEMA PB 1 - Panelboards.
7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.
2. NFPA 99 - Health Care Facilities.

E. Underwriters Laboratories Inc.:
1. UL 67 - Safety for Panelboards.
2. UL1022 – Line Isolation Monitors.
3. UL1047 – Isolated Power System Distribution Equipment.
4. UL 1283 - Electromagnetic Interference Filters.
5. UL 1449 - Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

B. Product Data: Submit catalog data showing specified features of standard products.

C. Main disconnect ratings (if applicable):
1. Voltage and ampacity ratings of the disconnect.
2. Voltage, ampacity, and interrupting ratings of fuses.

D. Branch device ratings including:
1. Voltage, ampacity, and interrupting ratings of fused branch device.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

1.7 MAINTENANCE MATERIALS

A. Furnish two of each panelboard key. Panelboards keyed alike.

PART 2 PRODUCTS

2.1 PANELBOARDS – GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet.
2. Ambient Temperature:

a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
b. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F

C. Short Circuit Current Rating:
1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings and schedules.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide 200 percent rated neutral bus and lugs where indicated, where oversized neutral conductors are provided, or where panelboards are fed from K-rated transformers.
3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1.
2. Outdoor Locations: Type 3R.
a. Furnish thermostatically controlled electric heaters sized to prevent condensation under expected weather conditions at Project site. Furnish control power transformer and terminals for separate connection of heater power circuit.
3. Boxes: Galvanized steel unless otherwise indicated.
a. Provide wiring gutters sized to accommodate the conductors to be installed.
b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
c. Provide removable end walls for NEMA Type 1 enclosures.
d. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
4. Fronts:
a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.

5. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided, list and label panelboards as a complete assembly including surge protective device.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
   a. Use zero sequence ground fault detection method unless otherwise indicated.
   b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
   c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.

M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

N. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

O. Load centers are not acceptable.

P. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.
2. Sub-feed lugs.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers:

1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer
5. Substitutions: Not permitted.

B. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

C. Conductor Terminations:

1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

2. Main and Neutral Lug Type: Mechanical.

D. Bussing:
1. Phase and Neutral Bus Material: Tin plated copper.
2. Ground Bus Material: Copper.

E. Circuit Breakers:
1. Provide bolt-on type.
2. Provide electronic trip circuit breakers where indicated on the drawings and panel schedules.
3. Provide thermal magnetic circuit breakers unless otherwise indicated.

F. Circuit breakers rated 1000 amps or more on solidly grounded 480V systems shall include ground fault protection.

G. Enclosures:
1. Provide surface-mounted enclosures unless otherwise indicated.
2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.
3. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
4. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
5. Provide clear plastic circuit directory holder mounted on inside of door.

H. Provide power style branch circuit breakers in life safety, critical and equipment branch distribution panelboards with electronic trip units for adjusting long time, short time, instantaneous, (LSI) and continuous current pickup current setting for automatic operation. Refer to drawings and panel schedules for locations and type.

2.3 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.
5. Substitutions: Not permitted.

B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.

D. Minimum Integrated Short Circuit Rating: Calculated based on primary transformer available SCR and as indicated on plans.

E. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip or molded case circuit breakers. Do not use tandem circuit breakers.
1. Provide bolt-on type.
2. Provide electronic trip circuit breakers where indicated on the drawings and panel schedules.
3. Provide thermal magnetic circuit breakers unless otherwise indicated.

F. Enclosure: NEMA PB 1, Type 1.

G. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards.

H. Cabinet Front: Flush cabinet front with concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard gray enamel.

2.4 OPERATING ROOM ISOLATION PANELBOARDS

A. Manufacturers:
1. Bender.
2. General Electric.
3. Square D.
4. Siemens.
5. Eaton/Cutler Hammer.
6. Substitutions: Not permitted.

B. DESCRIPTION
1. The operating room panels shall be located as indicated on the drawings.
2. The Line Isolation Monitor (LIM) used in these units shall indicate alarm when the total hazard current exceeds 5 mA. The remote indicator alarm unit shall be located in the operating room and connected to the panel supplying power to the circuits in that room. The panel shall be placed so its bottom edge is 61 inches above the finished operating room floor if the room is rated for flammable anesthetics. Location within the operating room is as indicated on the drawings.
3. A second indicator alarm unit shall be built into an annunciator containing indicator alarm units for all LIMs in the operating suite. This console will be located at the operating room (OR) supervisor’s station.

C. COMPONENTS:
1. TRANSFORMERS
a. The transformer shall be wound with an electrostatic shield between the primary and secondary windings. The shield shall be grounded to the enclosure. The electrostatic shield will be designed to prevent direct shorting of the primary winding to the secondary winding, and to reduce the coupling of harmonic distortions between the primary and secondary circuits.
b. The total leakage current shall comply with Tables 30.1 and 30.2 of UL1047.
c. Regulation to be certified not to exceed 2.5% at 0.8 power factor (PF) at 20° C above the full load continuous operating temperature in accordance with NEMA-ANSI standards.
d. The transformer is to be single-phase, 60 Hz with primary and secondary voltages as listed in the drawings and/or schedule.
e. In compliance with UL1047 Class H rated insulation, the temperature rise shall not exceed 115 degrees C above ambient temperature when under full load.
f. The core shall be of stacked design and securely clamped and bolted. The core and coils shall be internally isolated from the enclosure by means of a suitable vibration dampening system, varnish impregnated, and shall have a final wrap of insulating material to prevent exposure of bare conductors.
g. The design sound level of the completed units shall not exceed 27 dB for units up to 5 kVA, and 35 dB for 7.5 through 10 kVA units. Certified

sound level reports shall be furnished for each individual unit upon the request of the consulting engineer.

2. CIRCUIT BREAKERS
   a. All circuit breakers must be 2-pole with a minimum interrupting capacity of 10,000 amperes. Panels shall have a minimum capacity of 16 secondary circuit breakers. Refer to the panelboard schedule for quantity and sizes of breakers. All circuit breakers shall be thermal-magnetic type. Thermal-only type circuit breakers will not be considered as equal.
3. LINE ISOLATION MONITOR (LIM)
   a. The LIM shall use microprocessor-based digital signal processing to continually monitor the impedance from all secondary conductors of the isolated power systems to ground. The LIM shall be capable of measuring all combinations of capacitive and resistive faults including balanced, unbalanced and hybrid faults. LIMs which internally switch between either line and ground will not be accepted. The LIM shall not contribute more than 15□A to the total hazard current of the system being monitored.
   b. The LIM shall have the following specifications:
      1) Operating voltage 85 to 265 VAC
      2) Accuracy 5% or better
      3) Alarm level 2 or 5 mA (selectable)
      4) Alarm bandwidth Zero (0)
      5) Alarm hysteresis (on/off) 50 □A
      6) Mode Single- or three-phase
      7) Monitor hazard current 50 μA
      8) Operating frequency 50 or 60 Hz
   c. All of the listed specifications shall be contained within one unit and be user selectable thus allowing the LIM to be interchanged from system to system.
   d. The LIM shall incorporate a momentary test switch. When pressed, it shall check and recalibrate the unit. Additionally, the test switch shall perform a complete test of all indicating lamps and meters on the face of the LIM and at any remote indicating stations.
   e. The LIM shall use digital signal processing to determine the hazard current of the system being monitored. The microprocessor within the LIM shall be #MC68HC16Z1 as manufactured by Motorola. The algorithms used to determine the system hazard current shall be preprogrammed into the LIM's microprocessor. At least every 65 minutes, the unit shall recheck its calibration and recalibrate the system to original performance specifications. Additionally, by pressing the LIM's momentary test switch, an immediate check and recalibration of the LIM shall be performed.
   f. If internal components are more than 30% out of original specifications because of aging or failure, the LIM shall notify the user by displaying a unique error code thus eliminating the need for periodic manual testing to determine the unit's integrity. LIMs which use analog signal processing technology and/or require manual testing or recalibration will not be accepted.
   g. The LIM shall include an RS 485 port for remote communications.
   h. The LIM shall provide both analog and digital indication of the isolated power system's hazard current. Digital indication shall be provided by a digital meter and analog indication shall be provided by an LED bar graph type meter calibrated from 0 (zero) to 160% of the alarm setting of the LIM. LIMs with only analog or only digital indicating will not be accepted.

i. The LIM shall have a green safe light and red hazard light on the front panel. The red hazard light shall remain illuminated for the duration when the isolated power system hazard current is above the selected alarm level of the LIM. An audible alarm shall be incorporated into the unit and shall activate in conjunction with the red hazard light. The audible alarm shall have high, low, and off settings. A silence button shall be provided on the face of the unit to silence the audible alarm during fault conditions. Upon silencing the audible alarm, a yellow indicating light shall illuminate to indicate the audible alarm has been silenced. The red hazard light and yellow silence light shall automatically reset when the fault condition is eliminated. During fault conditions, the red hazard light and all red segments to the LED bar graph shall blink at a constant rate. All lamps are to be long life LED type.

j. A set of normally open and normally closed contacts, rated 3 amperes at 120 VAC shall be provided on the LIM for use with external alarm systems. The LIM shall also provide a 12 VAC output signal rated at 10 VA to power remote indicator alarm units. This 12 VAC output signal shall not increase the hazard current of the system being monitored. Provisions for connection of the remote metering shall also be provided as part of the LIM. These connections shall have the ability to operate either an analog or digital type remote meter.

k. The LIM shall incorporate a loss-of-ground feature which will activate the audible and visual alarms when connection is lost with the reference ground of the isolated power system being monitored. In addition to activating the alarm, the unit shall display an error code in the digital display of the LIM.

l. All switches, meters, and indicating lamps shall be flush with the face of the LIM to provide a neat and clean appearance. The entire front face of the unit shall have a polymer overlay that protects the unit from the intrusion of housekeeping cleaning agents. LIMs with exposed fuses, meters, switches, or circuit breakers will not be accepted.

m. The design of the LIM shall consist of two circuit boards interconnected by a ribbon connector. The two boards shall contain all of the unit's electrical components and be mounted in the rear housing of the LIM. A phenolic cover shall complete the assembly. The unit shall not contain any components, such as circuit breakers, meter, switches or indicating lamps, which are mounted on or attached to the front cover of the LIM. Access to the inside of the LIM shall be through the front of the unit thus eliminating the need to remove the unit from its mounting position to change any of the settings. Unique fasteners shall attach to the front cover of the unit to prevent unauthorized access to the interior of the LIM.

4. REMOTE INDICATOR ALARM

a. The remote indicator alarm shall be flush mounted and have a brushed stainless steel front trim. When the hazard current is within the predetermined limit for the circuits being monitored, a constant green light will remain illuminated. When the limit is exceeded, the green light will extinguish, a red indicator will illuminate, and an audible signal will sound.

b. A silencing switch for the audible signal shall be provided. When pressed, it will cause a yellow warning light to illuminate, indicating that the audible signal has been silenced. When the current flow to ground returns to an acceptable level, the unit will automatically reset. The wiring from the LIM to the indicator alarm shall not contribute any leakage current to the isolated system.

D. ENCLOSURES
1. The enclosure shall be 14-gauge steel which is degreased, phosphatized, primed, and finish baked enamel paint. The front trim shall be type 304 stainless steel with a #4 brushed finish. The enclosure will be flush mounted unless otherwise stated on the plans; units through 5 kVA shall have a maximum depth of eight inches; 7.5 kVA through 10 kVA shall have a maximum depth of twelve inches. The flush trim panels shall have a hinged door, with keyed lock, to give access to the circuit breakers and LIM, and to provide for testing.
2. The front panel shall not contain any type of grille or louver for ventilation. The panel and transformer shall be so designed that heat generated by the transformer under full load conditions shall not affect the normal operation of the circuit breakers and LIM. The maximum front panel temperature shall not exceed 30°C rise under full load continuous operation. Certification of this temperature test shall be provided to the consulting engineer upon request. The entire section behind the hinged door shall be of a dead front design. All hinges will be concealed.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
      2) 14,000 rms symmetrical amperes at 480 VAC.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.
   b. Provide compression lugs where indicated.
   c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
5. Electronic Trip Circuit Breakers: Where indicated on drawings and panel schedules, furnish solid state, microprocessor-based, true rms sensing trip units.
   a. Provide the following field-adjustable trip response settings:
      1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      2) Long time delay.
      3) Short time pickup and delay.
      4) Instantaneous pickup.
      5) Ground fault pickup and delay where ground fault protection is indicated.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
9. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
10. Do not use tandem circuit breakers.
11. Do not use handle ties in lieu of multi-pole circuit breakers.
12. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
13. Provide the following features and accessories where indicated or where required to complete installation:
    a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
    b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.
    c. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
    d. Under-voltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
    e. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required supports in accordance with Section 260529.

F. Install panelboards plumb.

G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

I. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Division 03.

J. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

K. Provide grounding and bonding in accordance with Section 260526.
1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
3. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels in accordance with NFPA 70 for normal and essential system panelboards serving the same patient care vicinity.

L. Install remote indicator alarms adjacent to the Nurses Station within each Operating Room, (1) remote indicator alarm for each isolation panel installed.

M. Operating Room isolation panelboard wiring:
1. Wiring within all panels shall meet all applicable NEC standards. Low leakage insulation shall be used on all secondary wiring. The total leakage for all panel types shall not exceed the values shown in table 29.1 of UL 1047.
2. The panel manufacturer shall provide certified test data on each individual panel as to maximum leakage of each complete assembly.
3. The contractor shall wire all external receptacles to the panels using copper stranded conductor having a cross-linked polyethylene insulation or equivalent with a dielectric constant of 3.5 or less. Under no circumstances shall wire pulling compound be used when pulling the wire for isolated circuits. All wiring shall be color-coded in accordance with NEC and appropriate NFPA standards.

N. Install all field-installed branch devices, components, and accessories.

O. Provide fuses complying with Section 262813 for fusible switches as indicated.

P. Install a permanent label indicating the panelboard or transformer where the power supply to the panel originates.

Q. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

R. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

S. Set field-adjustable circuit breaker tripping function settings as indicated with the results of the Overcurrent Protective Device Coordination Study.

T. Set field-adjustable ground fault protection pickup and time delay settings as indicated with the results of the Overcurrent Protective Device Coordination Study.

U. Provide filler plates to cover unused spaces in panelboards.

V. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
1. Emergency and night lighting circuits.
2. Fire detection and alarm circuits.
3. Communications equipment circuits.
4. Intrusion detection and access control system circuits.
5. Video surveillance system circuits.

W. Identify panelboards in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Division 01 - General Requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 800 amperes. Tests listed as optional are not required.
1. Perform insulation-resistance tests on all control wiring with respect to ground.
2. Test functions of the trip unit by means of secondary injection.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

E. Test GFCI circuit breakers to verify proper operation.

F. Test AFCI circuit breakers to verify proper operation.

G. Test shunt trips to verify proper operation.

H. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

I. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

A. See Division 01 – General Requirements.

B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

C. Adjust alignment of panelboard fronts.

D. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

A. See Division 01 – General Requirements.

B. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

C. Repair scratched or marred exterior surfaces to match original factory finish.

3.6 PROTECTION

A. Protect installed panelboards from subsequent construction operations.

END OF SECTION

SECTION 262653

ELECTRIC VEHICLE CHARGING EQUIPMENT

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 260400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Section includes EV charging equipment that provides Level 2 EV charging.

1.3 REFERENCES

A. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

B. Definitions
1. EV: Electric vehicle.
2. EV Cable: The off-board cable containing the conductor(s) to connect the EV power controller to the EV that provides both power and communications during energy transfer.
3. EV Capable: Parking spaces that include nearby termination of raceway (conduit) to a power source with sufficient electrical panel capacity designed for simultaneous charging of electric vehicles in all planned EV parking spaces. Electrical wiring need not be pulled through raceway (conduit) until charging station is installed.
4. EV Charger or EV Charging Equipment: See "EVSE".
5. EV Connector: A conductive device that, when electrically coupled to an EV inlet, establishes an electrical connection to the EV for the purpose of power transfer and information exchange. This device is part of the EV coupler.
6. EV Coupler: A mating EV inlet and connector set.
7. EV Inlet: The device in the vehicle into which the EV connector is inserted, and a conductive connection is made for the transfer of power and communication. This device is part of the EV coupler.
8. EV Make Ready: Parking spaces that include nearby termination of raceway (conduit) and electrical wiring pulled to a power source with sufficient electrical panel capacity for simultaneous charging of electric vehicles in all EV parking spaces.
9. EVSE: Electric Vehicle Supply Equipment. It includes the EV charging equipment and conductors, including the ungrounded, grounded, and equipment grounding conductors and EV cables, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for transferring energy between the premise wiring and the EV.

1.4 SYSTEM DESCRIPTION

A. Furnish and install electric vehicle charging equipment capable of supporting the following functions:
   1. Level 2 EV charging
   2. Be networked or internet addressable and capable of participating in a demand response program or time-of-use pricing to encourage off-peak charging.

B. Ensure that all locations of EV charging equipment is capable of receiving a CDMA or GSM cellular signal. The electrical contractor is responsible for this verification prior to purchasing or installing equipment. This does not apply if the installation uses Ethernet connectivity rather than cellular.

C. Provide the services of a manufacturer's technician to start and verify proper installation of all equipment.

1.5 SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for EV charging equipment.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For EV charging equipment.
   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. Detail fabrication and assembly of mounting assemblies for EV charging equipment.
   4. Include diagrams for power, signal, and control wiring.

C. Coordination Drawings: Area plans and 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 equipment will be attached.
   2. Electrical service.
   3. Communications service, including wireless communications equipment.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. See Division 01 – General requirements.

B. Operation and Maintenance Data: For EV charging equipment to include in operation and maintenance manuals.
   1. Programming data on installed system set-up.
   2. Third party payment system contracts.

C. Software and Firmware Operational Documentation:
   1. Online training and help documentation.
   2. Station activation sticker where required for network activation.

3.

1.7 QUALIFICATIONS

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

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 use.

C. Comply with UL 2231-1. UL 2231-2, UL 2594, and NEC Article 625.

D. Comply with SAE J1772.

E. Comply with FCC Part 15 Class A.

1.8 PRE-INSTALLATION MEETINGS

A. See Division 01 – General requirements.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. See Division 01 – General requirements.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.10 COORDINATION

A. See Division 01 – General requirements.

B. Coordinate exact location of charging equipment on site with concrete bases provided by Division 03.

C. Coordinate bolt pattern of bollard/pole mounted charging stations with supports provided by Division 03.

D. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.

1.11 WARRANTY

A. See Division 01 warranty requirements.

B. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EV charging units that fail(s) in materials or workmanship within specified warranty period.
   1. Standard Warranty Period: One year from date of Substantial Completion for the installer and three years from the date of shipment for the manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: EVSE LLC

B. Acceptable Alternates: Chargepoint, Eaton.

C. Substitutions – See Division 01 – General Requirements.

D. Source Limitations: Obtain EV charging equipment from single manufacturer.

2.2 EV CHARGING EQUIPMENT 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 use.

B. Comply with NFPA 70.

C. ADA compliant.

D. Metering: +/- 2 percent from 2 percent to full scale of output.

E. EV Charging Equipment Mounting: Bollard, pole or wall mount – see drawings for mounting type.

F. Enclosures:
   1. Rated for environmental conditions at installed location.
      a. Outdoor Locations: NEMA 250, Type 3R.
      b. Aluminum and UV-resistant plastic.
      c. Paint and Anodized or powder coated aluminum.
      d. Charging components protected by security screws.
      e. Charging connectors in locking holsters or using motorized, retractable cable system which does not require holsters.
      f. Meter, modem, and CPU, tamper resistant.

G. EV Cable and Connectors:
   1. SAE J1772 connector.
   2. Locking holster or using a motorized, retractable cable system which does not require holsters.
   3. 18-foot cable with cable management system (mechanical or motorized retractable).

H. Status Indicators:
   1. LEDs to indicate power, vehicle charging, charging complete, system status, faults, and service, as well as authorization.

I. Display Screen/LEDs:
   1. Daylight-viewable LCD screen with UV protection. Daylight readable and fingerprint resistant. The screen may be integral or detached in a separate kiosk-like module.
   2. Displays/indicates power, charging, charging complete, remote control, system status, faults, payment and pricing details, and service.

J. Networking:
   1. WAN Communications: Cellular GSM/GPRS and CDMA or Ethernet.
   2. LAN Communications: 2.4 GHz Wi-Fi 802.11b/g/n, ZigBee wireless or Ethernet Bridge.
   3. Capable of remote configuration, diagnostics and reporting.
   4. Capable of remote software updates.

K. Payment System:
   1. RFID (ISO 15693, ISO 14443), NFC, Contactless or insertion style credit card reader.
   2. PCI (Payment Card Industry) compliant.
   3. Capable of remote control and authorization including mobile phone application or toll free phone number.
   4. Capable of allowing free charging.
   5. Include all required network and port license fees.

L. Charging Network: Compatible with the Open Charge Point Protocol (OCPP) charging network.
   1. Multiple units shall independently connect to charging network.
   2. Multiple units shall have one unit designated as a master unit that is configured as a gateway unit between the EV charging equipment (or a kiosk-like module serving the same function) and the charging network.
   3. Individual units shall be capable of indicating station status and availability providing or connecting user to customer support and remote control, if networked, and via QR code or smartphone app.

2.3 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

B. Surge Withstand: 6 kV at 3000A.

C. Integral GFCI.

D. Auto-GFCI fault retry.

E. Input Power:
   1. As specified on drawings.
   2. Dual circuits do not need to be interlocked.

F. EV Charging Levels:
   1. Single vehicle: AC Level 2 maximum charging rate between 7.2 kW and 9.6 kW.
   2. Dual vehicles, AC Level 2 maximum charging rate between 7.2 kW and 9.6 kW.

G. Multiple vehicles simultaneously charging at a site using Automatic Power Load Management may be charged up to 9.6 kW. Using Power Sharing of dual chargers, two vehicles charging simultaneously will allow each 4.8 kW per hour of charge, reverting to

9.6 kW per hour if one of two vehicles is no longer charging. Multiple pairs of vehicles chargers can follow this pattern.

2.4 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping or otherwise protecting exposed finishes.

B. 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.

PART 3 EXECUTION

3.1 EXAMINATION

A. See Division 01 – General requirements.

B. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

C. Examine roughing-in for EV charging equipment electrical conduit to verify actual locations of conduit connections before equipment installation.

D. Examine walls, floors, and pavement for suitable conditions where EV charging equipment will be installed.

E. Notify the Architect or Engineer of any unsuitable conditions. Do not proceed with installation until unsuitable conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 413.

B. Concrete Base Mounting:
   1. Install EV charging equipment on a concrete base per manufacturers installation requirements or as indicated on drawings. Comply with requirements for concrete base specified in Division 03.
      a. Install dowel rods to connect concrete base to concrete floor or sidewalk where applicable. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
      b. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      c. Install anchor bolts to elevations required for proper attachment to supported equipment.
      d. Secure EV charging equipment to concrete base according to manufacturer's written instructions.

C. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors.

E. 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.

F. Circuit Breakers: Comply with Section 262416 "Panelboards."

G. Secure covers to enclosure.

3.3 CONNECTIONS

A. Connect wiring according to Section 260519 “Electrical Power Conductors and Cable.”

B. Comply with grounding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

C. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

D. 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.

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. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:
   1. For each unit of EV charging equipment, perform the following tests and inspections:
      a. Unit self-test.
      b. Operation test with load bank.
      c. Operation test with EV.
      d. Network communications test.

D. EV charging equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

3.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for the duration of an active Network Service Plan.

B. Upgrade Service: At Substantial Completion, remotely update software to latest version. Install and program software upgrades that become available while an active Network Service Plan is maintained. Upgrading software shall include operating system and new or revised licenses for using software.

3.8 TRAINING:

A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.

B. Provide training to personnel selected by the Owner on operation and basic maintenance of all systems and equipment.

C. Include 4 hours of training Owner’s staff.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Wall dimmers.

C. Receptacles.

D. Wall plates.

1.2 RELATED REQUIREMENTS

A. Section 01 – General Requirements

B. 26 0400 – General Conditions for Electrical Trades

C. Section 26 0519 – Building Wire and Cables.

D. Section 26 0526 - Grounding and Bonding for Electrical Systems.

E. Section 26 0503 – Equipment Wiring Connections.

F. Section 26 0533 – Raceways and Boxes for Electrical Systems.

G. Section 26 0553 - Identification for Electrical Systems.

H. Section 26 0923 - Lighting Control Devices.

I. Section 26 2913 - Enclosed Controllers.

1.3 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Revision H.

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Revision G.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction.

D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.

E. NEMA WD 1 - General Color Requirements for Wiring Devices.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

K. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.

L. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

M. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

N. UL 1917 - Solid-State Fan Speed Controls; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:
1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors and configurations.
1. Wall Dimmers: Include derating information for ganged multiple devices.
2. Surge Protection Receptacles: Include surge current rating, voltage protection rating (VPR) for each protection mode, and diagnostics information.

C. Samples: One for each type and color of device and wall plate specified.

D. Certificates for Surge Protection Receptacles: Manufacturer's documentation of listing for compliance with UL 1449.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data:
1. GFCI Receptacles: Include information on status indicators.

G. Project Record Documents: Record actual installed locations of wiring devices.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 - General Requirements, for additional provisions.
2. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
3. Extra Keys for Locking Switches: Two of each type.
4. Extra Wall Plates: One of each style, size, and finish.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Products: Listed, classified, and labeled as suitable for the purpose intended.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

D. Provide GFCI protection for receptacles installed within 6 feet of water source.

E. Provide GFCI protection in other than dwelling units for all single-phase receptacles rated 150 volts to ground or less and all three-phase receptacles rated 150 volts to ground or less, 100 amperes of less in: Bathrooms, Kitchens and on Rooftops

F. Provide GFCI protection for receptacles serving electric drinking fountains.

G. Unless noted otherwise, do not use combination switch/receptacle devices.

2.2 WALL SWITCHES – REFER TO SECTION 26 0923.

2.3 WALL DIMMERS - REFER TO SECTION 26 0923.

2.4 RECEPTACLES

A. Manufacturers:
1. Hubbell Incorporated
2. Leviton Manufacturing Company, Inc.
3. Pass & Seymour, a brand of Legrand North America, Inc.
4. Substitutions: See Division 01 - General Requirements.
5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.
3. Hospital Grade Receptacles: Listed as complying with UL 498 Supplement SD, with green dot hospital grade mark on device face.
4. Body color:
a. General Purpose Receptacles: color by Architect.
b. Emergency, Critical System receptacles: Red.

C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
2. Automatically Controlled Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.
3. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
4. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
5. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

D. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
a. Provide test and reset buttons of same color as device.
2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as

weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
5. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

E. USB Charging Devices:
1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
   a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
   b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.
2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.

2.5 WALL PLATES

A. Manufacturers:
1. Hubbell Incorporated
2. Leviton Manufacturing Company, Inc.
3. Pass & Seymour, a brand of Legrand North America, Inc.
4. Substitutions: See Division 01 - General Requirements.
5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Screws: Metal with slotted heads finished to match wall plate finish.
3. Finish selection: Stainless Steel unless otherwise noted.

C. Stainless Steel Wall Plates (for use in back-of house spaces): Brushed satin finish, Type 302 stainless steel.

D. Galvanized Steel Wall Plates (for use in damp back-of house locations): Rounded corners and edges, with corrosion resistant screws.

E. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

F. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that floor boxes are adjusted properly.

F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 0533 as required for installation of wiring devices provided under this section.
   1. Mounting Heights: Unless otherwise indicated, as follows:
      a. Wall Switches: 48 inches above finished floor.
      b. Wall Dimmers: 48 inches above finished floor.
      c. Fan Speed Controllers: 48 inches above finished floor.
      d. Receptacles: 18 inches above finished floor or 6 inches above counter.
      e. Install convenience GFCI type receptacles 36 to 48 inches above roof deck.
      f. Or at designated heights as indicated on drawings.
   2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
   4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
   5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in special application enclosures per manufacturer's instructions, provide stainless steel cover plates.

D. Install wiring devices in accordance with manufacturer's instructions.

E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper. When stranded conductors are used in lieu of solid, use insulated crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screw terminals.

I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

J. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

K. Install wiring devices plumb and level with mounting yoke held rigidly in place.

L. Install wall switches with OFF position down.

M. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

N. Do not share neutral conductor on branch circuits utilizing wall dimmers.

O. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

P. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

Q. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

R. Identify wiring devices in accordance with Section 26 0553.

3.4 FIELD QUALITY CONTROL

A. See Division 01 - General Requirements.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI protected receptacle for proper tripping operation according to manufacturer's instructions.

F. Inspect each surge protection receptacle to verify surge protection is active.

G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust presets for wall dimmers according to manufacturer's instructions and as directed by Architect.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 262813

FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fuses.

B. Spare fuse cabinet.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Section 26 0400 – General Conditions for Electrical Trades

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 2416 - Panelboards: Fusible switches.

E. Section 26 2819 - Enclosed Switches: Fusible switches.

F. Section 26 2913 - Enclosed Controllers: Fusible switches.

1.3 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.

E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses; Current Edition, Including All Revisions.

F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.

G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Division 01: General Requirements

B. Coordination:
1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
   a. Fusible Switches for Panelboards: See Section 26 2416.
   b. Fusible Enclosed Switches: See Section 26 2819.
   c. Fusible Switches for Enclosed Motor Controllers: See Section 26 2913.
2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain written direction before proceeding with work.

1.5 SUBMITTALS

A. Division 01 – General Requirements.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
1. Spare Fuse Cabinet: Include dimensions.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 - General Requirements.
2. Extra Fuses: One set(s) of three for each type and size installed.
3. Fuse Pullers: One set(s) compatible with each type and size installed.
4. Spare Fuse Cabinet Keys: Two.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Bussmann

B. Littelfuse, Inc.

C. Ferraz Shawmut

D. Substitutions: See Division 01- General Requirements.

2.2 APPLICATIONS

A. Service Entrance:
   1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
   2. Fusible Switches Larger than 600 Amperes: Class L, time-delay.

B. Feeders:
   1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
   2. Fusible Switches Larger than 600 Amperes: Class L, time-delay.

C. General Purpose Branch Circuits: Class RK1, time-delay.

D. Individual Motor Branch Circuits: Class RK1, time-delay.

E. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.

F. Primary Protection for Control Transformers: Class CC, time-delay.

2.3 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

H. Class J Fuses: Comply with UL 248-8.

I. Class L Fuses: Comply with UL 248-10.

J. Class T Fuses: Comply with UL 248-15.

K. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

L. Provide the following accessories where indicated or where required to complete installation:
   1. Fuseholders: Compatible with indicated fuses.
   2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

2.4 SPARE FUSE CABINET

A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.

B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that mounting surfaces are ready to receive spare fuse cabinet.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

C. Install spare fuse cabinet where indicated or as directed by the Owner..

D. Identify spare fuse cabinet in accordance with Section 26 0553.

END OF SECTION

SECTION 262819

ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fusible and nonfusible switches.

B. Related Sections:
1. Section 262813 - Fuses.
2. Section 260553 – Identification for electrical systems.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA FU 1 - Low Voltage Cartridge Fuses.
2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. See Division 01 – General Requirements.

B. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

A. See Division 01 – General Requirements.

B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.

5. Substitutions: See Division 01 – General Requirements.

B. Product Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.

D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

E. Furnish switches with entirely copper current carrying parts.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.
5. Substitutions: See Division 01 – General Requirements.

B. Product Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

D. Furnish switches with entirely copper current carrying parts.

2.3 SWITCH RATINGS

A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.

B. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install enclosed switches plumb. Provide supports in accordance with Section 260529.

B. Height: 5 feet to operating handle.

C. Install fuses for fusible disconnect switches. Refer to Section 262813 for product requirements.

D. Install engraved plastic nameplates in accordance with Section 260553.

E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

A. See Division 01 – General Requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION

SECTION 262826

ENCLOSED TRANSFER SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Automatic transfer switches.
   2. Manual transfer switches.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Division 03 - Cast-in-Place Concrete: Concrete equipment pads.

C. Section 260400 - General Conditions for Electrical Trades.

D. Section 260526 - Grounding and Bonding for Electrical Systems.

E. Section 260529 - Hangers and Supports for Electrical Systems.

F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

G. Section 262819 - Enclosed Switches: Safety switches not listed for use as transfer switch equipment.

H. Section 263213 - Engine Generators: For interface with transfer switches.
   1. Includes code requirements applicable to work of this section.
   2. Includes additional testing requirements.
   3. Includes related demonstration and training requirements.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 110 - Standard for Emergency and Standby Power Systems.

G. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

H. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
a. Engine Generators: See Section 263213.
2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Pre-installation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

C. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
1. Where applicable, include characteristic trip curves for overcurrent protective devices upon request.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

D. Warranty: Submit sample of manufacturer's warranty.

E. Evidence of qualifications for installer.

F. Evidence of qualifications for maintenance contractor (if different entity from installer).

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

H. Manufacturer's certification that products meet or exceed specified requirements.

I. Source quality control test reports.

J. Manufacturer's detailed field-testing procedures.

K. Field quality control test reports.

L. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

M. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

N. Maintenance contracts.

O. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

P. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Division 01 - General Requirements.
   2. Bypass/Isolation Transfer Switches: Provide accessories (ramps, dollies, etc.) necessary for removal of draw-out components.

1.6 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for system Level specified in Section 263213.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 100 miles of project site.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with power transfer systems of similar size, type, and complexity; manufacturer's authorized installer.

E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
   1. Contract maintenance office located within 100 miles of project site.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturers required service conditions during and after installation.

1.9 WARRANTY

A. See Division 01 – General Requirements.

B. Provide minimum one-year manufacturer warranty covering repair or replacement due to defective materials or workmanship commencing from the Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Transfer Switches - Basis of Design: ASCO Power Technologies as described below.

B. Transfer Switches - Other Acceptable Manufacturers:
1. ABB.
2. ESL Power Systems (Manual Transfer Switches only)
3. Russelectric.
4. Same as manufacturer of engine generator(s) used for this project.

C. Substitutions: See Division 01 - General Requirements.

D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

E. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.2 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:
   1. Utilize open transition transfer unless otherwise indicated or required.
   2. For transfer of highly inductive loads (e.g. large motors and transformers), utilize open transition transfer with in-phase monitor or delayed transition transfer.
   3. Neutral Switching (Single Phase, Three Wire and Three Phase, Four Wire Systems):
      a. Unless otherwise indicated or required, provide neutral switching:
         1) For systems with ground fault protection.
         2) Where the alternate/emergency source is a separately derived system.
   4. Provide signal before transfer contacts for transfer switches serving elevators.

D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.

E. Automatic Transfer Switch:
   1. Transfer Switch Type NEMA ICS 10, automatic transfer switch.
   2. Transition Configuration: Open Transition. Electrically operated, mechanically held.
   3. Voltage: As indicated on the drawings.
   4. Ampere Rating: As indicated on the drawings.
   5. Neutral Configuration: Switched neutral.
   6. Load Served: As indicated on the drawings.
   7. Primary Source: As indicated on the drawings.
   8. Alternate Source: As indicated on the drawings.

F. Manual Transfer Switch:
   1. UL 1008, manual transfer switch.
   2. Voltage: As indicated on the drawings.
   3. Ampere Rating: As indicated on the drawings.
   4. Neutral Configuration: Solid neutral (unswitched).
   5. Load Served: As indicated on the drawings.
   6. Primary Source: As indicated on the drawings.
   7. Alternate Source: As indicated on the drawings.

G. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

H. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

I. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

J. Switching Methods:
   1. Open Transition:
      a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.

b. Where in-phase transfer is indicated, utilize in-phase monitor to initiate transfer when phase angle difference between sources is near zero to limit in-rush currents.

2. Neutral Switching: Simultaneously switched neutral (break-before-make).
3. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

K. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

L. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1 or Type 12.
   b. Outdoor Locations: Type 3R or Type 4.
2. Provide lockable door(s) for outdoor locations.
3. Finish: Manufacturer's standard unless otherwise indicated.

M. Short Circuit Current Rating:
1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as indicated on the drawings.
2. Short Time Rating: Where the requirement for selectivity is indicated, provide transfer switches with short time ratings suitable for the maximum short time delay setting of the supply side overcurrent protective device.

N. Automatic Transfer Switches:
1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
2. Control Functions:
   a. Automatic mode.
   b. Test Mode: Simulates failure of primary/normal source.
      1) Mount control in cover of enclosure to simulate failure of normal source.
   c. Voltage and Frequency Sensing:
      1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
      2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
      3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
   d. Outputs:
      1) Contacts for engine start/shutdown.
      2) Auxiliary contacts; one set of normally open/normally closed contacts) for each switch position.
      3) Signal before transfer (load disconnect) contacts; for selective load disconnection prior to transfer.
   e. Adjustable Time Delays:
      1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
      2) Transfer to alternate/emergency source time delay.
      3) Retransfer to primary/normal source time delay.
      4) Signal before transfer (load disconnect) contact time delay.

5) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.

f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.

g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.
1) Start engine every 7 days; run for 30 minutes before shutting down.
2) Bypass exerciser control when normal source fails during exercise period.

h. Retransfer to Normal Switch: Bypasses time delays for retransfer to primary/normal source.
1) Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.

3. Status Indications – Enclosure cover mounted:
a. Connected to alternate/emergency source.
b. Connected to primary/normal source.
c. Alternate/emergency source available.
d. Primary/normal source available.

4. Alarm Indications for Closed Transition Transfer Switches:
a. Failure to synchronize.
b. Extended source interconnection/transfer switch locked out.

5. Other Features:
a. Event log.
b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
c. Remote monitoring capability via PC.

6. Automatic Sequence of Operations:
a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator.
b. Where applicable, initiate signal before transfer (load disconnect) contacts at programmable time before transfer.
c. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
d. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
e. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.
f. Required essential systems transfer switches and generator shall be configured in accordance with NFPA 70 to ensure emergency power is available within 10 seconds of failure of the normal supply. The Contractor shall coordinate starting and stabilization time with the generator supplier and set all time delays to ensure the required 10 second maximum time period is met.
g. Provide the following Sequencing of loads:
1) Sequence 1 – Life Safety and Critical Branch – shall comply with item f. above.
2) Sequence 2 – Equipment Branch – 20 sec. delay.
3) Sequence 3 – Chiller 1 – 30 sec. delay.
4) Sequence 4 – Chiller 2 – 40 sec. delay.

O. Manual Transfer Switches:
   1. Manual transfer switch shall consist of (2) two mechanically-interlocked molded case circuit breakers, cam-style male connectors, power distribution block and grounding terminals, all housed within a padlockable enclosure.
   2. Manual transfer switch enclosure shall be Type 3R, constructed of continuous seam-welded, powder coated galvanneal steel. The main access shall be through an interlocked, hinged door that extends the full height of the enclosure. Access for portable generator cables with female cam-style plugs shall be via
      a. Drawn flange cable entry openings in the bottom of enclosure for wall mount units, or
      b. Hinged lower door for pad mount units. A hinged flap door shall be provided to cover the cable openings when cables are not connected; the hinged flap door shall allow cable entry only after the main access door has been opened.
      c. Enclosure shall be powder coated after fabrication; color shall be wrinkle gray RAL 7035.
   3. Cam-style male connectors (inlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. Cam-style male connectors shall be color coded. Cam-style male connectors shall be provided for each phase and for ground, and shall also be provided for neutral if required. Each of the phase cam-style male connectors within the enclosure shall be factory-wired to a molded case circuit breaker. The ground cam-style male connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor. The neutral cam-style male connectors, if required, shall be factory wired to a power distribution block. None of the cam-style male connectors shall be accessible unless both molded case circuit breakers are in the “OFF” position and the main access door is open.
   4. A power distribution block shall be provided for load-side field wiring. The power distribution block shall be factory wired to the molded case circuit breakers.
   5. Molded case circuit breakers shall be UL Listed and the short circuit interrupt rating shall be a minimum of 35kAIC at 480VAC. Trip rating of the molded case circuit breakers shall be as shown on the drawings. One molded case circuit breaker shall be fed from utility power; the other molded case circuit breaker shall be fed from the cam-style male connectors to supply power from a portable generator. Both molded case circuit breakers shall include UL Listed door-mounted operating mechanisms, preventing the opening of the main access door unless both breakers are in the “OFF” position. Both molded case circuit breakers shall be mounted behind a deadfront panel. The load-side of the molded case circuit breakers shall not be energizable unless the main access door is closed and one of the molded case circuit breakers is in the “ON” position. The (2) molded case circuit breakers shall be safety interlocked by mechanical means to ensure that only one breaker can be closed at any given time.

P. Service Entrance Rated Transfer Switches – in addition to features specified above:
   1. Furnished with integral disconnecting and overcurrent protective device on the primary/normal source and with ground-fault protection where indicated.
   2. Listed and labeled as suitable for use as service equipment according to UL 869A.

Q. Interface with Other Work:
   1. Interface with engine generators as specified in Section 263213.
   2. Interface with elevators as specified in Division 14.
      a. Utilize signal before transfer contacts to disconnect elevator(s) served prior to transfer.

3. Interface with building automation system as specified in Section 230923.

2.3 ENGINE START MONITORING SYSTEM

A. Provide an engine start monitoring system to monitor the engine start circuits from the transfer switches; start the generator; and signal an alarm condition to the building fire alarm system and generator remote annunciator.

B. Basis of design: ASCO 5101 engine start circuit monitor.

C. The system shall include the following:
1. ATS Engine start modules (one for each transfer switch). Din rail mounted, coordinate mounting in transfer switches with transfer switch manufacturers.
2. Generator start module, locate at generator.
3. 24 VDC power supply for generator start module (battery backed up or from generator batteries).
4. UL listed DPDT relay at generator start module for separate dry contact signaling of generator remote annunciator and fire alarm system.

D. Specifications:
1. DDC Power: Generator Module - 9-27V; ATS module (power from circuit).
2. Internal ride through: 3 seconds maximum.
3. Operating Temperature: -4 to 158º F.
4. Maximum wiring distance: 1,000 ft. one way.
5. Maximum wire loop resistance: <100 ohms.
6. Generator start contacts: 1A @ 30 VDC (Form C).
7. Generator alarm contacts: 1A @ 30 VDC (Form C).

2.4 SOURCE QUALITY CONTROL

A. See Division 01 - General Requirements.

B. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned transfer switches.

B. Clean and repair existing transfer switches to remain or to be reinstalled.

C. Refer to paragraphs 3.3 & 3.4 for installation and testing requirements.

3.2 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive transfer switches.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.3 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required support and attachment in accordance with Section 260529.

E. Install transfer switches plumb and level.

F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 3 inch high concrete pad constructed in accordance with Division 03.

G. Provide grounding and bonding in accordance with Section 260526.

H. Install engraved plastic nameplates in accordance with Section 260553 and the following:
1. For Emergency Sources: A sign shall be placed at the service-entrance equipment, at the meter location, and on any equipment up to the service entrance-equipment indicating type and location of on-site emergency power sources.
2. For Essential System Sources: A sign shall be placed at the service entrance, at the meter location, and on any equipment up to the service entrance-equipment indicating type and location of on-site Essential System standby power sources.

3.4 FIELD QUALITY CONTROL

A. See Division 01 – General Requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Prepare and start system in accordance with manufacturer's instructions.

D. Automatic Transfer Switches:
1. Inspect and test in accordance with NETA ATS, except Section 4.
2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The control wiring insulation-resistance tests listed as optional are not required.
    a. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

E. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 263213.

F. Test the following for the Engine Start Monitoring System:
1. Generator module receiving 24 VDC power.

2. Signals from all ATS modules to the Generator module.
3. Alarm signals to external devices.
4. Engine start signal to generator.
5. DIP switch settings.
6. LED status signals.

G. Adjust control and sensing devices to achieve specified sequence of operation.

H. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

I. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.5 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Division 01 – General Requirements.

B. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.

C. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

D. Coordinate with related generator demonstration and training as specified in Section 263213.

3.7 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

3.8 MAINTENANCE

A. See Division 01 – General Requirements.

B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

D. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 4 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION

SECTION 262912

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes manual and magnetic motor controllers in individual enclosures.

B. Related Sections:

C. Related Sections:
1. Section 262813 - Fuses.
2. Section 260553 – Identification for Electrical Systems.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
5. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
6. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. See Division 01 – General Requirements.

B. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Test Reports: Indicate field test and inspection procedures and test results.

1.4 CLOSEOUT SUBMITTALS

A. See Division 01 – General Requirements

B. Project Record Documents: Record actual locations and ratings of enclosed controllers.

C. Operation and Maintenance Data: Submit Replacement parts list for controllers.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 MANUAL MOTOR CONTROLLER

A. Manufacturers:
1. General Electric.
2. Square D.
3. Eaton/Cutler Hammer.
4. Cerus Industrial.
5. Substitutions: See Division 01 - General Requirements.

B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, 1 NO and 1 NC auxiliary contact, and toggle operator.

C. Enclosure: NEMA ICS 6, to meet conditions of installation.

2.2 FRACTIONAL-HORSEPOWER MANUAL CONTROLLER

A. Manufacturers:
1. General Electric.
2. Square D.
3. Eaton/Cutler Hammer.
4. Cerus Industrial.
5. Substitutions: See Division 01 - General Requirements.

B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and toggle operator.

C. Enclosure: NEMA ICS 6, to meet conditions of installation.

2.3 FULL-VOLTAGE NON-REVERSING CONTROLLERS

A. Manufacturers:
1. General Electric.
2. Square D.
3. Eaton/Cutler Hammer.
4. Cerus Industrial.
5. Substitutions: See Division 01 - General Requirements.

B. Product Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

C. Control Voltage: 120 volts, 60 Hertz.

D. Overload Relay: NEMA ICS 2; bimetal (electronic preferred).

E. Product Features:
1. Auxiliary Contacts General: NEMA ICS 2, 2 each, field convertible contacts in addition to seal-in contact.
2. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty type.
3. Pilot Device Contacts: NEMA ICS 5.
4. Pushbuttons: Shrouded type.
5. Indicating Lights: LED type.
6. Selector Switches: Rotary type (HOA).
7. Relays: NEMA ICS 2.
8. Control Power Transformers: 120 volt secondary, in each motor starter. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

F. Combination Controllers: Combine motor controllers with disconnect in common enclosure, using fusible switch conforming to NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses. Obtain IEC Class 2 coordinated component protection.

G. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from [steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install enclosed controllers plumb. Provide supports in accordance with Section 260529.

B. Height: 5 feet to operating handle.

C. Install fuses for fusible switches. Refer to Section 262813 for product requirements.

D. Select and install overload heater elements in motor controllers to match installed motor characteristics.

E. Install engraved plastic nameplates. Refer to Section 260553 for product requirements and location.

F. Neatly type label and place inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.2 FIELD QUALITY CONTROL

A. See Division 01 – General Requirements

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION

SECTION 263213

ENGINE GENERATORS

PART 1 GENERAL

1.1 SUMMARY

A. Packaged engine generator system and associated components and accessories:
1. Engine and engine accessory equipment.
2. Alternator (generator).
3. Generator set control system.
4. Generator set enclosure.

B. Required emergency systems transfer switch and generator shall be configured in accordance with NFPA 70 to ensure emergency power is available within 10 seconds of failure of the normal supply. The contractor shall coordinate transfer switch time delays with the enclosed transfer switch supplier based on generator starting and stabilization time to ensure the required 10 second maximum time period is met.

C. Related Sections:
1. Division 03 – Concrete
2. Section 260526 - Grounding and Bonding for Electrical Systems.
3. Section 260529 – Hangers and Supports for Electrical Systems.
4. Section 260553 - Identification for Electrical Systems.
5. Section 262826 - Enclosed Transfer Switches.
6. Division 33 - Utilities

1.2 REFERENCES

A. ASTM D975 - Standard Specification for Diesel Fuel Oils

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.

C. NECA/EGSA 404 - Standard for Installing Generator Sets.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.

F. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.

G. NEMA MG 1 - Motors and Generators.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

I. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements

K. NFPA 110 - Standard for Emergency and Standby Power Systems.

L. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

M. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

N. UL 2085 - Protected Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

O. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
a. Transfer Switches: See Section 262826.
b. Switchboards: See Section 262413.
2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Pre-installation Meeting: Convene two weeks before starting work of this section; require attendance of all affected installers.

1.4 SUBMITTALS

A. Division 01 – General Requirements.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
1. Include generator set sound level test data.
2. Include characteristic trip curves for overcurrent protective devices.
3. Include alternator thermal damage curve.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

D. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

E. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.

F. Specimen Warranty: Submit sample of manufacturer's warranty.

G. Evidence of qualifications for installer.

H. Evidence of qualifications for maintenance contractor (if different entity from installer).

I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

J. Manufacturer's factory emissions certification.

K. Manufacturer's certification that products meet or exceed specified requirements.

L. Source quality control test reports.

M. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
1. Certified prototype tests.
2. Torsional vibration compatibility certification.
3. NFPA 110 compliance certification.
4. Certified rated load test at rated power factor.

N. Manufacturer’s detailed field testing procedures.

O. Field quality control test reports.

P. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

Q. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

R. Sample maintenance contract, submitted to owner for review and approval.

S. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

T. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Division 01 – General Requirements.
2. Extra Fuses: One of each type and size.
3. Extra Filter Elements: One of each type, including fuel, oil and air.
4. Furnish one set of tools required for preventative maintenance of engine generator system. Package tools in adequately sized metal tool box.
5. Provide a full tank of fuel for each diesel generator after final testing and startup is complete.

1.5 QUALITY ASSURANCE

A. Comply with the following:
1. NFPA 70 (National Electrical Code).

2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
1. Authorized service facilities located within 100 miles of project site.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.

E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
1. Contract maintenance office located within 100 miles of project site.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.7 WARRANTY

A. Division 01 – General Requirements

B. Furnish service and maintenance of engine generator and transfer switch for one year from Date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Division 01 – General Requirements

B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

D. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 4 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

PART 2 PRODUCTS

2.1 SERVICE CONDITIONS

A. Provide engine generator system and associated components suitable for operation under the service conditions at the installed location, including but not limited to:
   1. Altitude
   2. Ambient Temperature
   3. Available Natural Gas Pressure

2.2 MANUFACTURERS

A. Packaged Engine Generator Set:
   1. MTU Onsite Energy
   2. Kohler Co
   3. Cummins Power Generation Inc
   4. Caterpillar Inc
   5. Substitutions: Division 01 – General Requirements

B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

C. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.3 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:
1. Application: Emergency and Essential electrical systems.
2. Configuration: Single packaged engine generator set operated independently (not in parallel).

D. Packaged Engine Generator Set:
1. Type: Diesel (compression ignition).
2. Power Rating: As indicated on drawings.
3. Voltage: As indicated on drawings.
4. Line Side Circuit Breaker(s):
   a. Type: Molded case with fully adjustable trip unit.
   b. Trip Rating: As indicated on drawings.
      1) Provide LSIG type circuit breaker.
   c. Features:
      1) Shunt trip.
      2) Auxiliary contacts.
      3) 100% Rated.
   d. Provide circuit breaker matching circuit breakers provided with electrical distribution for selectivity.
   e. Refer to drawings for available fault current ratings.
   f. All circuit breakers rated 1200 amps and above shall have arcflash reduction maintenance system (ARMS). Provide the following:
      1) Arcflash Reduction Maintenance System Switch.
         a) Provide a maintenance OFF ON selector switch on the compartment door to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity.
         b) Provide a lock feature for the ARMS switch so that it may be locked in either the OFF or ON maintenance mode position.
         c) Provide a blue LED indicating light to indicate trip unit is in the ARMS mode.

E. Generator Set General Requirements:
1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
2. Factory-assembled, with components mounted on suitable base.
3. List and label engine generator assembly as complying with UL 2200.
4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.

F. Starting and Load Acceptance Requirements:
1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).

G. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

H. Sound Level Requirements:
1. Comply with applicable noise level regulations.

I. Interface with building automation system as specified in Section 230993.

J. Mounting: Furnish unit with suitable spring-type vibration isolators and mount on structural steel base.

2.4 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Diesel (Compression Ignition):
1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
2. Fuel Storage: Sub-base fuel tank.
3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
5. Main Fuel Tank (Bulk Tank): Comply with Section 231113.
6. Day Tank:
a. Provide separately mounted double-wall day tank with secondary containment, with fuel transfer pump(s), valves, and automatic controls suitable for operation in the configuration to be installed; listed and labeled as complying with UL 142.
b. Tank Capacity: Size for minimum of 48 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes; account for fuel returned to main fuel tank (bulk tank), if applicable; account for heating where engine fuel is returned to day tank without fuel cooler.
c. Alarm Indications/Shutdowns:
1) Low fuel level alarm; provides local indication and activates remote output contact.
2) Critical low fuel level alarm; provides local indication and activates remote output contact; can be configured to shut down engine to prevent loss of fuel prime.
3) High fuel level; provides local indication and activates remote output contact.
4) Critical high fuel level alarm; provides local indication and activates remote output contact; shuts down fuel transfer supply pump.
5) Secondary containment leak detection alarm; provides local indication and activates remote output contact; shuts down fuel transfer supply pump.

d. Features:
1) Direct reading fuel level gage.
2) Normal atmospheric vent.
3) Emergency pressure relief vent.

7. Sub-Base Fuel Tank:
a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
c. Features:
1) External double-wall sub base tank
2) Direct reading fuel level gage.
3) Normal atmospheric vent.
4) Emergency pressure relief vent.
5) Fuel fill opening with lockable cap.
6) Dedicated electrical conduit stub-up area.
7) Low fuel level switch.
8) Leak detection switch; located within secondary containment interstitial space for detection of primary tank fuel leak.

C. Engine Starting System:
1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
a. Battery Type: Lead-acid.
b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
c. Recognized as complying with UL 1236.
d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
f. Provide alarm output contacts as necessary for alarm indications.
5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.

D. Engine Speed Control System (Governor):
1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Multiple Engine Generator Sets Operated in Parallel: Provide electronic isochronous governors with automatic load sharing controls.

3. Generator Sets Used with Closed Transition Transfer Switches: Provide electronic isochronous governor with frequency regulation suitable for transfer.
4. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.

F. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
3. Ducted Radiators: Where ducted radiator air discharge is to be field-installed, provide suitable radiator duct flange/adapter.
4. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements.

H. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions.

I. Batteries: Heavy duty, diesel starting type lead-acid storage batteries. Match battery voltage to starting system. Furnish cables and clamps.

J. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.

K. Battery Charger: Current limiting type designed to float at 2.17 volts for each cell and equalize at 2.33 volts for each cell. Furnish overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Furnish wall mounted enclosure to meet NEMA 250, Type 1 requirements.

L. Weather-protective Enclosure: Refer to paragraph below.

2.5 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with re-connectable leads for 3 phase alternators.

B. Exciter:
   1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
   2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300% of rated output current for 10 seconds.
   3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
   4. Voltage Regulation (with shunt or PMG excitation): Plus/minus two percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 1, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

H. Voltage Regulation: Furnish generator mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Furnish manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain.

I. Product Description: NEMA MG1, reconnectable brushless synchronous generator with brushless exciter.

J. Insulation Class: F.

K. Temperature Rise: 105 degrees C Continuous.

L. Enclosure: NEMA MG1, open drip proof.

2.6 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:
   1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
   2. Generator Set Control Functions:
      a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
      b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
      c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
      d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.

e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.

3. Generator Set Status Indications:
   a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
   b. Current (Amps): For each phase.
   c. Frequency (Hz).
   d. Real power (W/kW).
   e. Reactive power (VAR/kVAR).
   f. Apparent power (VA/kVA).
   g. Power factor.
   h. Duty Level: Actual load as percentage of rated power.
   i. Engine speed (RPM).
   j. Battery voltage (Volts DC).
   k. Engine oil pressure.
   l. Engine coolant temperature.
   m. Engine run time.
   n. Generator powering load (position signal from transfer switch).
4. Generator alarm indicators and gauges:
   a. Frequency Meter: 45-65 Hz. range, 3.5 inch dial.
   b. AC Output Voltmeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
   c. AC Output Ammeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
   d. Engine running time meter.
   e. Oil pressure gauge.
   f. Water temperature gauge.
   g. Push-to-test indicator lamps, one each for:
      1) Low oil pressure.
      2) Low water temperature.
      3) Overspeed.
      4) Overcrank.
      5) High engine temperature.
      6) High engine temperature pre-alarm.
      7) Low fuel, main tank.
      8) Low coolant level.
      9) EPS supplying load.
      10) Control switch not in automatic position.
      11) High battery voltage.
      12) Low battery voltage.
      13) Low cranking voltage.
      14) Battery charger AC failure.
      15) Lamp test.
      16) Low starting air pressure.
      17) Low starting hydraulic pressure.
      18) Air shut-down damper (when used).
5. Additional features:
   a. Engine start/stop selector switch.
   b. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
   c. Additional visual indicators and alarms in accordance with by NFPA 110.
   d. Remote Alarm Contacts: Factory wire DPDT contacts to terminal strip for remote alarm functions in accordance with NFPA 110.

C. Remote Annunciator Panel: Flush mounted panel with brushed stainless steel. Furnish alarm horn, and indicators and alarms as follows:
   1. Low oil pressure.
   2. Low water temperature.
   3. Overspeed.
   4. Overcrank.
   5. High engine temperature.
   6. High engine temperature pre-alarm.
   7. Low fuel, main tank.
   8. Low coolant level.
   9. Control switch not in automatic position.
   10. Low cranking voltage.
   11. Air shut-down damper (when used).
   12. System ready.
   13. Line power available.
   14. Generator power available.
   15. Lamp test and horn silence switch.

D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.7 GENERATOR SET ENCLOSURE

A. Enclosure Type: Sound attenuating, weather protective.

B. Enclosure Material: Steel or aluminum.

C. Hardware Material: Stainless steel.

D. Color: Manufacturer's standard.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.

I. Utilize an upward discharging radiator hood.

J. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

K. Weather-protective Level II Sound Attenuating Enclosure: Reinforced steel housing allowing access to control panel and service points, with lockable doors and panels. Furnish with fixed louvers, fuel tank, battery rack, silencer, stainless steel hardware, and emergency power off button. Housing shall attenuate sound pressure produced by generator, as measured 25 feet from assembly, to a level of 78 dBA maximum.

2.8 SOURCE QUALITY CONTROL

A. Division 01 – General Requirements.

B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

C. Generator Set production testing to include, at a minimum:
1. Operation at rated load and rated power factor.
2. Single step load pick-up.
3. Transient and steady state voltage and frequency performance.
4. Operation of safety shutdowns.

D. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

E. Provide shop inspection and testing of completed assembly.

F. Make completed engine-generator assembly available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner & Architect/Engineer at least seven days before inspection is allowed.

2.9 Generator Access Platform: Prefabricated Code-compliant aluminum working platform along both sides of generator. Platform shall include:

A. 42" wide platform with OSHA compliant railings.

B. Adjustable leg height to set platform at base of enclosure, above fuel tank.

C. Manufacturers:
1. REDD Team
2. C.A.P. (Compliant Access Products, LLC)
3. Substitutions: Division 01 – General Requirements.

D. Final dimensions of platform to be based on dimensions of approved generator and sub-base fuel tank.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

B. Verify that rough-ins for field connections are in the proper locations.

C. Verify that mounting surfaces are ready to receive equipment.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Unless otherwise indicated, mount generator set on properly sized concrete pad, minimum of 6 inches above grade, constructed in accordance with Division 03. Provide suitable vibration isolators, where not factory installed.

F. Provide required support and attachment in accordance with Section 260529.

G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

H. Provide grounding and bonding in accordance with Section 260526.

I. Identify system wiring and components in accordance with Section 260553.

J. Install engraved plastic nameplates in accordance with Section 260553

1. For Emergency Sources: A sign shall be placed at the service-entrance equipment, at the meter location, and on any equipment up to the service entrance-equipment indicating type and location of on-site emergency power sources.

2. For Standby Sources: A sign shall be placed at the service-entrance equipment, at the meter location, and on any equipment up to the service-entrance equipment that indicates the type and location of on-site optional standby power sources.

K. Ground and bond generator and other electrical system components in accordance with Section 260526.

3.3 FIELD QUALITY CONTROL

A. Division 01 – General Requirements.

B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.

D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

F. Preliminary inspection and testing to include, at a minimum:
1. Inspect each system component for damage and defects.

2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
3. Check for proper oil and coolant levels.

G. Prepare and start system in accordance with manufacturer's instructions.

H. Perform acceptance test in accordance with NFPA 110, Paragraph 7.13: Installation Acceptance.
1. Inspection and testing to include, at a minimum:
   a. Verify compliance with starting and load acceptance requirements.
   b. Verify voltage and frequency; make required adjustments as necessary.
   c. Verify phase sequence.
   d. Verify control system operation, including safety shutdowns.
   e. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
   f. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test). Contractor shall provide load bank to simulate building load as required.

I. Provide field emissions testing where necessary for certification.

J. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.

K. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

L. Submit detailed reports indicating inspection and testing results and corrective actions taken.

M. Inspect and test in accordance with NETA ATS, except Section 4.

N. Perform inspections and tests listed in NETA ATS, Section 7.22.

O. Above testing shall be documented in writing and furnished as a part of the O&M manuals, and provided to engineer prior to closeout.

3.4 ADJUSTING

A. Division 01 – General Requirements.

B. Adjust generator output voltage and engine speed to meet specified ratings.

3.5 CLEANING

A. Division 01 – General Requirements.

B. Clean engine and generator surfaces. Replace oil and fuel filters with new.

C. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. Division 01 – General Requirements

B. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.
5. Describe loads connected to emergency and standby system and restrictions for future load additions.
6. Simulate power outage by interrupting normal source, and demonstrate system operates to provide emergency and standby power.

D. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.7 PROTECTION

A. Protect installed engine generator system from subsequent construction operations.

END OF SECTION

SECTION 264100

FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes air terminals, interconnecting conductors, grounding, and bonding for lightning protection.

1.2 REFERENCES

A. Lightning Protection Institute:
1. LPI 175 - Standard of Installation.

B. National Fire Protection Association:
1. NFPA 780 - Standard for the Installation of Lightning Protection Systems.

C. Underwriters Laboratories Inc.:
1. UL 96 - Lightning Protection Components.
2. UL 96A - Installation Requirements for Lightning Protection Systems.

1.3 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems: Electrical system grounds.

B. Surge Protection for Wiring Systems: Specified in individual system requirements.

1.4 SYSTEM DESCRIPTION

A. Description: Conductor system protecting entire building and having UL Master Label.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate location and layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.
1. Where conductors or grounds are to be embedded or concealed in other construction, submit shop drawings at least 30 days prior to start of construction.
2. If concrete-encased grounds are to be used and are not shown in the contract documents, provide sufficient data to determine concrete encasement dimensions and location.
3. Include data on actual ground resistance determined by field measurement in accordance with NFPA 780.
4. Include engineering analysis of equalization of potential to metal bodies within the structure.
5. Include access panels, test holes, and disconnecting means for maintenance.

C. Product Data: Submit catalog sheets showing dimensions and materials of each component, and include indication of listing in accordance with UL 96.

D. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

F. Certificate of Compliance: Submit certificate from Underwriter's Laboratories indicating approval of lightning protection systems.

1.6 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

C. Operation and Maintenance Data: Provide recommended inspection and testing plan, including recommended intervals, to achieve periodic maintenance as recommended in NFPA 780; provide customized plan reflecting actual installation configuration with specific installed components identified.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment with minimum five years documented experience and a member of Lightning Protection Institute.

B. Installer: Authorized installer of manufacturer with minimum five years documented experience and certified by Lightning Protection Institute.

C. Inspection Agency: Underwriter’s Laboratories, Inc. (UL).

D. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.8 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 COORDINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Coordinate Work with exterior and interior finish installations.

C. Coordination with Concrete Work: Coordinate the embedding of lightning protection components in concrete.

D. Coordination with Roofing Work: Ensure adequate attachment of strike terminals and conductors without damage to roofing.

E. Preinstallation Meeting: Convene a meeting at least at least two weeks prior to commencement of any work affected by lightning protection system requirements to discuss prerequisites and coordination required by other installers; require attendance by representatives of installers whose work will be affected.

PART 2 PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM

A. Lightning Protection System: Provide complete system complying with NFPA 780, including air terminals, bonding, interconnecting conductors and grounding electrodes.
   1. Provide system that protects:
      a. The entire structure.
      b. Open air areas within building footprint.
   2. Coordinate with other grounding and bonding systems specified.
   3. Treat isolated non-grounded protruding metal items as specified by NFPA 780 for heavy-duty stacks.
   4. Determine ground resistance by field measurement.
   5. Provide copper, bronze, or stainless steel components, as applicable; no aluminum.
   6. Provide disconnecting means and access panels or similar devices to allow complete periodic inspection and testing as described by NFPA 780 Annex D.
   7. Provide system certified by Underwriters Laboratories or the Lightning Protection Institute.

B. Strike Terminals: Provide strike (air) terminals on the following:
   1. Roofs.
   2. Penthouse roofs.
   3. Parapets.
   4. Roof mounted equipment.
   5. Stacks.

2.2 COMPONENTS

A. Manufacturers:
   1. Erico.
   2. Hager.
   3. Alltec
   4. Substitutions: Section 016000 - Product Requirements.

B. Product Listing: UL 96.

C. Air Terminals:
   1. Material: Copper.
   2. Configuration: Solid.
   3. Use adhesive base for single-ply roof installations.
   4. Air Terminal for Chimney: Lead-coated copper.
   5. Grounding Rods: Solid copper.
   6. Ground Plate: Copper.

7. Conductors:
   a. Material: Copper.
   b. Configuration: Cable.

D. Connectors and Splicers: Bronze.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated on shop drawings.

B. Coordinate work with installation of roofing and exterior and interior finishes.

3.2 INSTALLATION

A. Install in accordance with UL 96A.

B. Install in accordance with referenced system standards and as required for specified certification.

C. Connect conductors using mechanical connectors or exothermic welding process; protect adjacent construction elements and finishes from damage.

D. Conceal interior conductors within building finishes. Conceal exterior conductors where practical.

E. Bond exterior metal bodies on building to lightning protection system, and provide intermediate level interconnection loops 60 feet on center.

3.3 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform visual inspection as specified in NFPA 780 as if this were a periodic follow-up inspection.

C. Perform continuity testing as specified in NFPA 780 as if this were testing for periodic maintenance.

D. Obtain the services of the specified certification agency to provide inspection and certification of the lightning protection system, including performance of any other testing required by that agency.

E. Perform inspection and testing in accordance with UL 96A.

END OF SECTION

SECTION 265100

LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires.

B. Exterior luminaires.

C. Emergency lighting units.

D. Exit signs.

E. Ballasts and drivers.

F. Fluorescent and LED Driver emergency power supply units.

G. Lamps.

H. Luminaire accessories.

1.2 RELATED REQUIREMENTS

A. Section 26 0533 – Raceways and Boxes for Electrical Systems.

B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.

D. Section 26 2726 - Wiring Devices: Manual wall switches and wall dimmers.

E. Lighting Fixture Schedule as indicated on drawings.

1.3 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; current edition.

B. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type); 2002.

C. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; 2011.

D. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).

E. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.

F. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules: 2015.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

H. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.

I. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.

J. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2015.

K. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.

L. UL 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

M. UL 924 Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

N. UL 1598 - Luminaires; Current Edition, Including All Revisions.

O. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility, installed by other sections or others.
4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Division 01 – General Requirements.

B. Shop Drawings:
1. Indicate dimensions and components for each luminaire of the manufacturer.
2. Provide photometric calculations where luminaires are proposed for substitution upon request.

C. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of luminaire 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.

D. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
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 life, output (lumens, CCT, and CRI), and energy efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA LM-79 and IESNA LM-80.
    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: Photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    c. TM-21 report for L70 rating at color temperature specified.
6. Ballasts/drivers: Include wiring diagrams and list of compatible lamp configurations.
7. Lamps/LED arrays: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.

E. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.

F. Samples:
1. Provide one sample(s) of each specified luminaire upon request.
2. Provide one sample(s) of each custom luminaire.
3. Provide one sample(s) of each luminaire proposed for substitution upon request.
4. Provide one sample(s) of each product finish illustrating color and texture upon request.
5. Provide a mockup of selected luminaires upon request.
6. Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

G. Certificates for Dimming Ballasts/Drivers: Manufacturer's documentation of compatibility with dimming controls to be installed.

H. Field quality control reports.

I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

J. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

1.6 EXTRA PRODUCTS

A. Provide [2] emergency lighting units complete with all labor and materials required for installation as directed by the Local Authority Having Jurisdiction.

B. Provide [6] universal exit signs complete with all labor and materials required for installation as directed by the Local Authority Having Jurisdiction.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 – General Requirements.
2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.
3. LED Drivers: Furnish two of each driver type
4. Furnish [1] replacement battery for each battery type and size.

D. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.7 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.8 QUALIFICATION DATA: For testing laboratory providing photometric data for luminaires.

A. Seismic Qualification Certificates: For luminaires, 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.

B. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

1.9 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.10 FIELD CONDITIONS

A. Maintain field conditions within the manufacturers required service conditions during and after installation.

1.11 WARRANTY

A. See Division 01 – General Requirements.

B. Section 26 0400 – General Requirements for Electrical Trades.

C. Unless otherwise noted in Lighting Fixture Schedule, Provide three year manufacturer warranty for all LED luminaires, including drivers.

D. Provide five year manufacturer warranty for batteries for emergency lighting units.

E. Provide ten year manufacturer warranty for batteries for self-powered exit signs.

F. Provide five year manufacturer warranty for fluorescent and LED Driver emergency power supply units.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in Lighting Fixture Schedule included on the drawings.

B. Substitutions: See Division 01- General Requirements, except where individual luminaire types are designated with substitutions not permitted and the following:
   1. Section 26 04 00 – Product Requirements and as follows:
      a. Approved equals to the basis of design fixture as listed in the Lighting Fixture Schedule shall be accepted for review with the proposed substitute fixture meeting the following minimum requirements:
         1) Be of the same general size, style and shape, including but not limited to lens construction and shading.
         2) Be of equal or better quality and construction.
         3) Be supplied with all required accessories to match the specified fixture.
         4) Be supplied with all remote drivers, power supplies and cabling lengths to meet specified performance and control.
         5) Provide the same or better distribution, efficiency, source lumen output, and L70 lumen depreciation metric.
      b. Provide point by point photometric calculations at the request of the Engineer for evaluation.
      c. The basis of design fixture listed in the Lighting Fixture Schedule lists part numbers, specifications, options, accessories and source output available at the time of design. Substitutions shall meet these requirements as scheduled.
      d. The evaluation of an approved equal shall be at the sole discretion of the Architect and Engineer.

2.2 INTERIOR LUMINAIRES

A. Manufacturers:
1. Manufacturers represented by Apex Lighting.
2. Manufacturers represented by Visible Light.
3. Manufacturers represented by Exposure.
4. Substitutions: See paragraph 2.1, B.

B. Provide products that comply with requirements of NFPA 70.

C. Provide products that are listed and labeled as complying with UL 1598, where applicable.

D. Provide products listed, classified, and labeled as suitable for the purpose intended.

E. Provide products complying with Federal Energy Management Program (FEMP) requirements.

F. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, drivers, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

G. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

H. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

I. Recessed Luminaires:
1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
4. Air-Handling Recessed Luminaires: Suitable for air supply/return, heat removal, or combination as indicated.
a. Luminaires for Air Supply/Return: Provide air control blades where indicated.
b. Luminaires for Heat Removal: Provide heat removal dampers where indicated.

J. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.

K. LED Luminaires:
1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

L. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.

M. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

N. Luminaires in Special Environments:
1. Showers: Provide with non-conductive trim.
2. Wet Locations: Provide with sealed and gasketed lens.
3. Infectious Environments: Provide with sealed and gasketed lens and anti-microbial finish.
4. Clean Rooms: Provide with sealed and gasketed lens, IP65 Rating and clean room rating as indicated.

2.3 EMERGENCY LIGHTING UNITS

A. Manufacturers:
1. Manufacturers represented by Apex Lighting.
2. Manufacturers represented by Visible Light.
3. Manufacturers represented by Exposure.
4. Substitutions: See paragraph 2.1, B.

B. Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

C. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps/LED arrays to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

D. Battery:
1. Sealed maintenance free lead calcium unless otherwise indicated.
2. Size battery to supply all connected lamps/LED arrays, including emergency remote heads where indicated.

E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

F. Provide low voltage disconnect to prevent battery damage from deep discharge.

G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

2.4 EXIT SIGNS

A. Manufacturers:
1. Manufacturers represented by Apex Lighting.
2. Manufacturers represented by Visible Light.
3. Manufacturers represented by Exposure.
4. Substitutions: See paragraph 2.1, B.

B. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

1. Number of Faces: Single or double as indicated or as required for the installed location.
2. Directional Arrows: Universal type for field adjustment sized so that they are clearly visible at a distance of 40 feet as required by local codes.
3. Mounting: Wall, ceiling or pendant as indicated. Provide universal mount exit signs where indicated.
4. Housing: Varies, refer to Lighting Fixture Schedule.
5. Face: Varies, refer to Lighting Fixture Schedule.

C. Self-Powered Exit Signs:
1. Product Description: UL 924 self-contained emergency lighting unit.
2. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
3. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.
4. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
5. Provide low-voltage disconnect to prevent battery damage from deep discharge.
6. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

D. Self-Luminous Exit Signs: Internally illuminated by tritium gas sealed inside phosphor lined gas tubes, requiring no electrical power to operate, with a service life of 20 years unless otherwise indicated.

E. Special Wording Signs: Provide with special wording as indicated.
1. Where indicated, provide with international symbol of accessibility complying with state and local codes.
2. Provide combination exit/special wording signs where indicated.

F. Accessories:
1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
2. Provide compatible accessory wire guards where indicated.

2.5 EXTERIOR LUMINAIRES

A. Manufacturers:
1. Manufacturers represented by Apex Lighting.
2. Manufacturers represented by Visible Light.
3. Manufacturers represented by Exposure.
4. Substitutions: See paragraph 2.1, B.

B. Provide products that comply with requirements of NFPA 70.

C. Provide products that are listed and labeled as complying with UL 1598, where applicable.

D. Provide products listed, classified, and labeled as suitable for the purpose intended.

E. Provide products complying with Federal Energy Management Program (FEMP) requirements.

F. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, drivers, reflectors, lenses, housings, poles, brackets, bases, vibration dampers, isolation pads and other components required to position, energize and protect the lamp and distribute the light.

G. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

H. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

I. Provide IESNA full cut-off classified products unless otherwise indicated or provide products with backlight, uplight and glare (BUG) ratings as indicated.

J. Provide products with IESNA light distribution as indicated.

K. Provide products with internal/external house-side shields as indicated.

L. LED Luminaires:
1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data or as indicated.

M. Poles:
1. Material and Finish: Refer to Lighting Fixture Schedule.
2. Section Shape and Dimensions: Refer to Lighting Fixture Schedule.
3. Height: As indicated on Drawings or as scheduled.
4. Base: Nonbreakaway.
5. Accessories:
   a. Handhole.
   b. Anchor bolts.
   c. Base Cover.
   d. Pre-drilled for luminaire mounting.
6. Loading Capacity Ratings:
   a. Provide with EPA rating suitable for maximum wind load in area, including EPA for attached luminaires and all required accessories.
   b. Consult with local authorities for wind loading requirements.

2.6 MATERIALS

A. 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.
4. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
5. Diffusers and Globes:
   a. Refer to Interior Lighting Fixture Schedule for types.

b. 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.
c. Glass: Annealed crystal glass unless otherwise indicated.
d. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

6. Housings:
   a. Extruded-aluminum housing and heat sink unless otherwise indicated.
   b. Powder-coat finish unless otherwise indicated, color selection by Architect.
7. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   a. Label shall include the following lamp characteristics:
      1) "USE ONLY" and include specific lamp type.
      2) Lamp diameter, shape, size, wattage, and coating.
      3) CCT and CRI for all luminaires.

B. METAL FINISHES
1. 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.

2.7 BALLASTS AND DRIVERS

A. Manufacturers:
1. eldoLED.
2. General Electric Company.
3. Lutron Electronics Company.
4. Osram Sylvania.
5. Philips Lighting Electronics/Advance.
6. Substitutions: See Division 01- General Requirements, Product Requirements.
7. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.
8. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.
9. Provide ballasts/drivers compatible with the approved lighting control systems.

B. Ballasts/Drivers - General Requirements:
1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

C. LED Drivers:
1. Product Description: LED dimming driver.
   a. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
   b. Digital (DALI Low Voltage Controlled) Dimming Drivers
   c. Digital Multiplex (DMX Low Voltage Controlled) Dimming Drivers
2. General:
   a. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions),

natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.

b. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.

c. Driver must limit inrush current.
   1) Base specification: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps (^2) – seconds.
   2) Preferred Specification: Meet or exceed 30mA(^2)s at 277VAC for up to 50 watts of load and 75A at 240us at 277VAC for 100 watts of load.

d. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.

e. No visible change in light output with a variation of plus/minus 10 percent line voltage input.

f. Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.

g. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
   1) Adjustment of forward LED voltage, supporting 3V through 55V.
   2) Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
   3) Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

h. Driver must be able to operate for a (+/- 10%) supply voltage of 120V through 277VAC at 60Hz.

i. Driver should be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.

j. Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.

3. Light Quality

a. Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 1 percent and 10% relative light output where indicated, or 100 – 10% light standard. Driver shall respond similarly when raising from 1% to 100%

b. 1) Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels

c. Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.

d. Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-1 percent luminaire shall have:

1) LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
2) Base specification: Flicker index shall less that 5% at all frequencies below
3) 1000 Hz.
4) Preferred specification: Flicker index shall be equal to incandescent, less that 1% at all frequencies below 1000 Hz.

4. Control Input
   a. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
      1) Must meet IEC 60929 Annex E for General White Lighting LED drivers
      2) Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
      3) Must meet ESTA E1.3 for RGBW LED drivers
   b. Digital (DALI Low Voltage Controlled) Dimming Drivers
      1) Must meet IEC 62386
   c. Digital Multiplex (DMX Low Voltage Controlled) Dimming Drivers
      1) Must meet DMX / RDM: USITT DMX512A and ANSI E1.20 (Explore & Address)
      2) Capable of signal interpolation and smoothing of color and intensity transitions
5. Driver: Approved by dimming system manufacturer as suitable for operation with control unit and suitable for LED source type and quantity specified for luminaire.

2.8 FLUORESCENT AND LED DRIVER EMERGENCY POWER SUPPLY UNITS

A. Manufacturers:
   1. Manufacturers represented by Apex Lighting.
   2. Manufacturers represented by Visible Light.
   3. Manufacturers represented by Exposure.
   4. Substitutions: See paragraph 2.1, B.
   5. Manufacturer Limitations: Where possible, for each type of luminaire provide emergency power supply units produced by a single manufacturer.
   6. Where a specific manufacturer or model is indicated elsewhere in the light fixture schedule or on the drawings, substitutions are not permitted unless explicitly indicated.

B. Description: Self-contained emergency power supply units suitable for use with indicated luminaires, complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

C. Compatibility:
   1. Ballasts: Compatible with electronic, standard magnetic, energy saving, and dimming AC ballasts, including those with end of lamp life shutdown circuits.
   2. Lamps: Compatible with low-mercury lamps.
   3. LED Drivers: Compatible with LED driver and LED arrays.

D. Operation: Upon interruption of normal power source, solid-state control automatically switches connected lamp(s)/LED arrays to the emergency power supply for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

E. Battery: Sealed maintenance-free high-temperature nickel cadmium unless otherwise indicated.

F. Emergency Illumination Output: Refer to Lighting Fixture Schedule.

G. Diagnostics: Provide accessible and visible multi-chromatic combination test switch/indicator light to display charge, test, and diagnostic status and to manually activate emergency operation.

H. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status and field selectable audible alert.

I. Operating Temperature: From 32 degrees F (0 degrees C) to 122 degrees F (50 degrees C) unless otherwise indicated or required for the installed location.

J. Accessories:
1. Where not integral to fixture, provide compatible accessory remote combination test switch/indicator light mounted on ceiling adjacent to unit or as indicated.

2.9 LUMINAIRE FIXTURE 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. Single-Stem Hangers: 1/2 or 3/4-inch steel tubing with heavy duty 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 minimum.

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.

F. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 0533 as required for installation of luminaires, emergency lighting units and exit signs provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install products in accordance with manufacturer's instructions.

D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

F. Suspended Ceiling Mounted Luminaires:
1. Do not use ceiling tiles to bear weight of luminaires.
2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
4. Secure pendant-mounted luminaires to building structure.
   a. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
5. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box, heavy-duty swivel hangers and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
6. 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.
7. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
8. See Division 09 - Finishes where suspended grid ceiling is specified for additional requirements.

G. Recessed Luminaires:
1. Install trims tight to mounting surface with no visible light leakage.
2. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
3. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
4. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
5. Install recessed luminaires to permit removal from below.

H. Suspended Luminaires:
   1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
   2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
   3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet (1.2 m) between supports.
   4. Install canopies tight to mounting surface.
   5. Secure pendant-mounted luminaires to building structure.
      a. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   6. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box, heavy-duty swivel hangers and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
   7. 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.
   8. Unless otherwise indicated, support pendants from swivel hangers.

I. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

J. Install accessories furnished with each luminaire.

K. Bond products and metal accessories to branch circuit equipment grounding conductor.

L. Air Handling Luminaires: Interface with air handling accessories furnished and installed under Section 23 3600.

M. Emergency Lighting Units:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
   2. Install lock-on device on branch circuit breaker serving units.
   3. Install plumb and adjust to align with building lines and with each other. Secure to prevent movement.

N. Exit Signs:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
   2. Install lock-on device on branch circuit breaker serving units.
   3. Install plumb and adjust to align with building lines and with each other. Secure to prevent movement.
   4. Install suspended exit signs using pendants from swivel hangers. Install pendant lengths required to suspend sign at height indicated or as instructed by the Authority Having Jurisdiction.

O. Fluorescent and LED Driver Emergency Power Supply Units:
   1. For field-installed units, install inside luminaire unless otherwise indicated. Where installation inside luminaire is not possible, install on top of luminaire.
   2. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal ballast(s) in luminaire. Bypass local switches, contactors, or other lighting controls.
   3. Install lock-on device on branch circuit breaker serving units.

P. Remote Ballasts/drivers: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.

Q. Identify luminaires connected to emergency power system in accordance with Section 26 0553.

R. Install specified lamps in each luminaire.

S. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

T. Install accessories furnished with each luminaire.

U. Connect luminaires to branch circuit using flexible conduit, except for emergency lighting which shall be in conduit completely.

V. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

W. Ground and bond interior luminaires in accordance with Section 26 0526.

3.4 FIELD QUALITY CONTROL

A. See Division 01 – General Requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Test self-powered exit signs, emergency lighting units, and emergency power supply units to verify proper operation upon loss of normal power supply.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.

C. Air-Handling Luminaires with Air Control Blades or Heat Removal Dampers: Adjust as indicated or as required for proper airflow as directed by Architect.

D. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.6 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

B. Clean photometric surfaces as recommended by the manufacturer.

3.7 CLOSEOUT ACTIVITIES

A. See Division 01- General Requirements

B. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

C. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 270526

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Wire.
2. Mechanical connectors.
3. Exothermic connections.

B. Related Sections:
1. Section 26 0526 - Grounding and Bonding for Electrical Systems.
2. See Division 01 – General Requirements.

1.2 REFERENCES

A. Building Industry Consulting Service International, Inc.
1. BICSI TDM Manual - Telecommunications Distribution Methods Manual.

B. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

C. Telecommunication Industry Association/Electronic Industries Alliance:
1. TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.3 SYSTEM DESCRIPTION

A. Communications grounding systems use the following elements as grounding electrodes:
1. Building grounding electrode.

B. Do not use the following elements as grounding electrodes:
1. Building plumbing system.

1.4 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms maximum.

1.5 SUBMITTALS

A. See Division 01 – General Requirements.

B. Product Data: Submit data on grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

D. Manufacturer's Installation Instructions: Submit for active electrodes.

E. Manufacturer's Certificate: Certify meet or exceed specified requirements.

1.6 CLOSEOUT SUBMITTALS

A. See Division 01 – General Requirements.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.7 QUALITY ASSURANCE

A. Provide grounding, surge protection and lightning protection of telecommunications system in accordance with latest version of Grounding, Bonding and Electrical Protection chapter of the BICSI TDM Manual, TIA/EIA 607, and NFPA 70.

B. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. See Division 01 – General Requirements.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 COORDINATION

A. See Division 01 – General Requirements.

B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 WIRE

A. Material: Stranded copper.

B. Grounding Conductor: Copper conductor bare.

C. Bonding Conductor: Copper conductor bare.

2.2 MECHANICAL CONNECTORS

A. Manufacturers:
1. Copperweld, Inc.

2. Erico, Inc.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical
5. Substitutions: See Division 01 - General Requirements.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.3 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Cadweld, Erico, Inc.
2. Copperweld, Inc.
3. ILSCO Corporation.
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical.
6. Substitutions: See Division 01 - General Requirements.

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.2 INSTALLATION

A. Install in accordance with BICSI TDM Manual, TIA/EIA 607, and NFPA 70.

B. Provide grounding/bonding for each communication rack using #4 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor. Terminate to copper communication grounding Bar in each telecommunications room.

C. Bond main telecommunications grounding system to building grounding electrode system at main electrical service entrance location with #3/0 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor.

D. Routing of grounding conductor shall be as short and direct as practical.

E. Install routing of bonding conductors with minimum number of bends and splices. Use sweeping bends.

F. Install bonding connections with listed bolts, crimp pressure connectors, clamps, or lugs.

G. Within each MDF/IDF room, provide ground bar mounted to isolating stand offs, with pre-drilled holes for accepting cable spade lugs. Each ground bus shall connect to the next with #3/0 AWG insulated green wire, and the final termination shall be at the main demarc location.

H. Position busbars near associated equipment and insulate from supports.

I. Construct busbars of copper, 4 inches x 8 inches by 1/4 inch thick with pilot holes for ground lug.

J. Bond backbone cabling at each sheath opening.

K. Ground/bond data cabinets, racks, cable trays.

L. Conduit stub/sleeves shall be installed with ground bushings and form a continuous bonded surface. Bond each end of metallic conduit sleeves with bonding conductor matching installed conductor.

M. Install ground from each piece of equipment to grounding bar via an insulated cable no smaller than 6 AWG stranded copper wire. Install proper grounding lug on cable where connecting to racks and grounding bar.

N. Label grounding conductors and grounding bus bars in accordance with BICSI guidelines.

O. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.3 FIELD QUALITY CONTROL

A. See Division 01 – General Requirements.

B. Visually inspect from each bus bar to main grounding electrode service location.

C. Test in accordance with BICSI TDM Manual, TIA/EIA 607, and NFPA 70.

D. When improper grounding is found, check entire project and correct. Perform retest.

END OF SECTION

SECTION 270529

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications

1.2 SUMMARY

A. Section Includes:
1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Equipment bases and supports.
7. J-hooks for communications cabling.

B. Related Sections:
1. Division 03 – Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Division 07 – Penetration Firestopping.
3. Section 26 0529 – Hangers and Supports for Electrical Systems.

1.3 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

B. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

1.4 SUBMITTALS

A. Division 01 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of hangers and supports.

E. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience, approved by manufacturer.

1.6 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. Electroline Manufacturing Company.

3. O-Z Gedney Co.
4. Thomas and Betts
5. Substitutions: Division 01 - Product Requirements.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Division 01 - Product Requirements

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Division 01 - Product Requirements

B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

A. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for conduit, cable tray, raceway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

D. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. PSI Link-Seal.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6 J-HOOK SUPPORTS

A. Manufacturers:
1. Easton/Cooper B-Line – “BCH” Series
2. Caddy
3. Chatsworth
4. Substitutions: See Division 1 – Product Requirements

B. Product Description: Low-voltage and communication fasteners for routing of cabling from telecommunication room to work area outlet. J-hooks shall support all communications cabling in the project. Including, but not limited to, Category 6, 6A, fiber, speaker cabling, coaxial, security, and others.

C. Specifications:
1. Pre-galvanized steel finish
2. Static load capacity: 30 lbs
3. Quick latching cable retainer

D. Furnish with all required connectors, fasteners and accessories.

E. J-Hooks shall be sized to correctly support the number of cables, which pass through them. Under no circumstances shall cable quantity exceed 50 in any given support. Fill capacity shall be as required by code for conduit. That is to say that every J-Hook shall have a maximum of 40 percent fill capacity. Install additional supports as required.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Obtain permission from Architect/Engineer before using powder-actuated anchors.

D. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
2. Steel Structural Elements: Provide beam clamps, spring steel clips, and welded fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

G. Backboxes for communications devices shall be permitted to be supported from a grid ceiling. A tile bridge shall be furnished for this purpose. Refer to Section 27 05 33.

H. Overhead speakers, plenum boxes, audiovisual equipment, and other devices weighing more than a standard electrical backbox shall be supported via a threaded rod fastened to the building structure.

I. J-hooks shall be furnished with cable-to-beam fasteners and shall be fastened to the building structure.

J. Separate J-hooks shall be furnished and installed for different systems. The following systems shall be routed in separate j-hook pathways:
   1. Data cabling
   2. Speaker cabling
   3. Security cabling

K. J-hook pathways shall be separated from power cabling by a minimum of 12 inches.

L. J-hook pathways shall be separated from the load side wiring of dimmer controls by a minimum of 24 inches.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Division 03.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install chrome plated steel escutcheons at finished surfaces.

3.6 FIELD QUALITY CONTROL

A. Division 01 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.7 CLEANING

A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.

3.8 PROTECTION OF FINISHED WORK

A. Division 01 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 270533

CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:
1. Section 07 8413 – Penetration Firestopping.
2. Section 26 0503 – Equipment Wiring Connections.
3. Section 26 0533 – Raceway and Boxes for Electrical Systems.
4. Section 27 0526 – Grounding and Bonding for Communications Systems.
5. Section 27 0529 – Hangers and Supports for Communications Systems.
6. Section 27 0553 – Identification for Communications Systems.
7. Section 33 7119 – Electrical Underground Ducts and Handholes

1.3 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 – Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 – Specification for Electrical Metallic Tubing, Zinc Coated.

B. National Electrical Manufacturers Association:
1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 – Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
5. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.4 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations necessary for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than 5 feet outside Foundation Wall: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.

C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.

D. In or Under Slab on Grade: Provide rigid steel conduit with rigid steel conduit sweeps. Only allowed where necessary to devices at on grade millwork.

E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.

F. Wet and Damp Locations: Provide rigid steel conduit, electrical metallic tubing. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.

G. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

H. Exposed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

I. Dry Finished Locations: Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

J. Exposed Dry Finished Locations: Provide surface metal raceway and fittings. Unless specified on drawings, requires design team approval for use of surface metal raceway in finished locations. Coordinate all vertical runs of surface raceway with the architect prior to installation.

1.5 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.6 SUBMITTALS

A. Division 01 – Submittal Procedures: Submittal procedures.

B. Product Data: Submit for the following:
1. Liquidtight flexible metal conduit.
2. Nonmetallic conduit.
3. Nonmetallic tubing.
4. Raceway fittings.
5. Conduit bodies.
6. Surface raceway.
7. Wireway.
8. Pull and junction boxes.
9. Handholes.

C. Manufacturer’s Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.7 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:
1. Record actual routing of conduits larger than 2 inch.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Division 01 – Product Requirements: Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.9 COORDINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Coordinate installation of outlet boxes for equipment connected under Section 26 0503.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

D. Division 27 contractor is responsible to fully coordinate with the site and concrete contractors and all other trades when routing conduit underground or underslab. See Part 3 of this Section for additional backfilling requirements.

PART 2 PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Division 01 – Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; all steel fittings.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Anamet Electrical.
3. Allied Tube and Conduit.
4. Substitutions: Division 01 – Product Requirements.

B. Product Description: Interlocked steel construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Division 01 – Product Requirements.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression (damp locations), and set screw type.

2.4 SURFACE METAL RACEWAY

A. Manufacturers:
1. Hubbell Wiring Devices.
2. Thomas & Betts Corp.
3. The Wiremold Co.
4. Substitutions: Division 01 – Product Requirements.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Size: as indicated on drawings.

D. Finish: Manufacturers standard finish as selected by Architect.

E. Fittings, Boxes, and Extension Rings: Furnish manufacturer’s standard accessories; match finish on raceway.

F. Provide building wire within steel surface mounted raceway such as manufactured by Wiremold. For areas where data and power devices are located on same wall, provide divided raceway (Wiremold 4000 or equivalent).

2.5 WIREWAY

A. Manufacturers:
1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Hoffman.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Steel NEMA 1 wireway when inside building. Steel NEMA 3R wireway when outside building.

C. Knockouts: Manufacturer’s standard.

2.6 OUTLET BOXES

A. Manufacturers:
1. Erico Products.

2. Raco.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 – Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs.
2. Concrete Ceiling Boxes: Concrete type.

C. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

D. Wall Plates for Finished Areas: As specified in Section 26 27 26.

E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

F. Ceiling backboxes: Provide tile bridge to support mounting of backbox from ceiling grid in areas with grid ceiling. In other areas without grid ceiling, backbox shall be supported from building structure.

2.7 PULL AND JUNCTION BOXES

A. Manufacturers:
1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 – Product Requirements.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 26 27 16.

D. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
1. Material: Galvanized cast iron.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 26 05 26.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 27 0529.

C. Identify raceway and boxes in accordance with Section 27 0553.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION – RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 27 0529; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 27 05 29.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit under slab from point-to-point.

K. Maintain clearance between raceway and piping for maintenance purposes.

L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.

R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

S. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases. Seal conduit with spray foam watertight sealant after cable is installed and tested with Polywater AFT spray foam sealant or approved equal.

T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

X. Close ends and unused openings in wireway.

Y. Division 27 contractor is responsible to fully coordinate with the site and concrete contractors and all other trades when routing conduit underground or underslab. Routing of conduit underslab may be acceptable, provided spacing of conduits is adequate for proper backfilling of area surrounding conduits. Adequate spacing shall mean a minimum of 3-inches for backfilling with sand. Proposed conduit routing, installation and methods and backfilling procedures shall be submitted to the Engineer for review.

3.4 INSTALLATION – BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as specified in section for outlet device.

B. Coordinate communications device locations with furniture plan and receptacle locations to accommodate the intended purpose prior to rough-in.

C. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

D. Orient boxes to accommodate wiring devices.

E. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

F. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

G. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

H. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

J. Install stamped steel bridges to fasten flush mounting outlet box between studs.

K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

L. Install adjustable steel channel fasteners for hung ceiling outlet box.

M. Do not fasten boxes to ceiling support wires or other piping systems.

N. Support boxes independently of conduit.

O. Install gang box where more than one device is mounted together. Do not use sectional box.

P. Install gang box with plaster ring for single device outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07 Section “Penetration Firestopping”.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.

C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.6 ADJUSTING

A. Division 01 – Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.7 CLEANING

A. Division 01 – Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 270536

CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications

1.2 SUMMARY

A. Section includes cable tray.

B. Related Sections:
1. Section 07 8413 – Penetration Firestopping.
2. Section 27 0526 - Grounding and Bonding for Communications Systems.
3. Section 27 0529 - Hangers and Supports for Communications Systems.
4. Section 27 0553 - Identification for Communications Systems.

1.3 REFERENCES

A. ASTM International:
1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. National Electrical Manufacturers Association:
1. NEMA FG 1 - Nonmetallic Cable Tray Systems.
2. NEMA VE 1 - Metal Cable Tray Systems.
3. NEMA VE 2 - Metal Cable Tray Installation Guidelines.

1.4 SUBMITTALS

A. See Division 01 – General Requirements.

B. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.

C. Product Data: Submit fittings and accessories.

D. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 CLOSEOUT SUBMITTALS

A. See Division 01 – General Requirements.

B. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience, and with service facilities within 100 miles of Project.

1.7 PRE-INSTALLATION MEETINGS

A. See Division 01 – General Requirements.

B. Convene minimum one week prior to commencing work of this section.

PART 2 PRODUCTS

2.1 METAL LADDER-TYPE CABLE TRAY

A. Manufacturers:
1. B-Line Systems.
2. Chalfant.
3. Thomas and Betts.
4. Substitutions: See Division 01 - General Requirements.

B. Product Description: NEMA VE 1, Class 20C ladder type tray.

C. Material: Aluminum.

D. Finish: Galvanized to ASTM A123/A123M; galvanize after fabrication..

E. Inside Width: 18 inches or as indicated on Drawings.

F. Inside Depth: 5 inches or indicated on Drawings.

G. Straight Section Rung Spacing: 9 inches on center.

H. Inside Radius of Fittings: 24 inches.

I. Furnish manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

2.2 WARNING SIGNS

A. Engraved Nameplates: 1/2 inch black letters on yellow laminated plastic nameplate, engraved with: WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

PART 3 EXECUTION

3.1 INSTALLATION

A. Install metal cable tray in accordance with NEMA VE 2.

B. Support trays and fasten to structure and finishes in accordance with Section 26 0529. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of 10 ft. maximum.

C. Install expansion connectors where recommended by manufacturer or as indicated on Drawings.

D. Install firestopping in accordance with Section 07 84 00 to sustain ratings when passing cable tray through fire-rated elements.

E. Ground and bond metal cable tray in accordance with Section 26 05 26.
   1. Provide continuity between tray components.
   2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
   3. Install 2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each component.
   4. Make connections to tray using mechanical, compression or exothermic connectors.

F. Install warning signs at 50 feet centers along cable tray, located to be visible.

END OF SECTION

SECTION 270553

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications

1.2 SUMMARY

A. Section Includes:
1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Underground Warning Tape.

B. Related Sections:
1. Division 09 – Painting and Coating: Execution requirements for painting specified by this section.
2. Section 26 0553 – Identification for Electrical Systems.

C. Division 01 – Submittal Procedures: Submittal procedures.

D. Product Data:
1. Submit manufacturer’s catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

E. Manufacturer’s Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

A. Division 01 – Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Division 01 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Division 01 – Product Requirements: Environmental conditions affecting products on site.

B. Install labels only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Division 01 – Product Requirements.

B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.

C. Letter Size:
1. 1/8 inch high letters for identifying individual equipment and loads.
2. 1/4 inch high letters for identifying grouped equipment and loads.

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Division 01 – Product Requirements.

B. Labels: Embossed, pre-printed adhesive tape, with 3/16 inch white letters on black background.

2.3 CONDUIT AND RACEWAY MARKERS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Division 01 – Product Requirements.

B. Description: Nameplate fastened with straps.

C. Color:
1. Voice System: Blue lettering on white background.
2. Data System: White lettering on black background.

D. Legend:
1. Voice system: VOICE.
2. Data System: DATA
3. Audiovisual Systems: AV

2.4 UNDERGROUND WARNING TAPE

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Division 01 - Product Requirements.

B. Description: 4 inch wide plastic tape, detectable type, colored yellow with suitable warning legend describing buried communications lines.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:
1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
4. Secure nameplate to equipment front using screws.
5. Install nameplates for the following:
a. Equipment racks and cabinets.

C. Conduit Marker Installation:
1. Install conduit marker for each conduit longer than 10 feet.
2. Conduit Marker Spacing: 20 feet on center.

END OF SECTION

SECTION 275116

PUBLIC ADDRESS SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Supply and install an overhead, multi-zoned public address system.

B. Related Sections:
1. Division 01 – General Requirements
2. Section 26 0400 – General Conditions for Electrical Trades
3. Section 27 0529 – Hangers and Supports for Communications Systems.
4. Section 27 0533 – Raceway and Boxes for Communications Systems.
5. Section 27 0553 – Identification for Communications Systems.
6. Section 27 5313 – Clock Systems.
7. Section 27 1000 – Structured Cabling (for Ethernet cable requirements).

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. Underwriters Laboratories (UL).

C. EIA/TIA 568-B.

1.4 SYSTEM DESCRIPTION

A. Zoned public address system for voice and music reproduction.

B. Input components:
1. Compact disc player.
2. AM/FM tuner.
3. Paging Stations.

C. Features:
1. Interface to telephone system.
2. One-way paging by zone.
3. Emergency paging override.
4. Distribution of background music.

D. The Contractor shall furnish and install all equipment including, but not limited to, outlet boxes, wiring, speakers, and all other necessary equipment to provide a complete operating system as indicated with the contract documents. Provide all necessary wall plates, specialty boxes, etc.

E. The system shall provide distribution of intercom, overhead paging, emergency paging, tones, program material, and emergency messaging.

F. Contract documents are detailed only to the extent required to show design intent. It shall be understood and agreed upon by the Contractor that all work described herein shall be complete in every detail.

G. Furnish additional items not mentioned herein to meet requirements as specified, to include hardware, rack panels, terminations, and other devices that are required for installation.

H. Labor furnished shall be trained and experienced in telecommunication systems.

I. All equipment unless otherwise specified, shall be new, free from defects, and the best craftsmanship in its class.

J. All manufactured equipment shall be installed as recommended by the manufacturers, or as indicated in their published installation manual.

K. Furnish and install necessary equipment, backboxes, supports and enclosures.

L. Furnish and install all necessary wire.

M. Perform initial programming of system and audio level adjustments.

N. Perform final programming of system and audio level adjustments.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Indicate layout of equipment mounted in racks and cabinets, component interconnecting wiring, and wiring diagrams of field wiring to speakers and remote input devices.

C. Product Data: Provide data showing electrical characteristics and connection requirements for each component.

D. Test Reports: Indicate satisfactory completion of each test recommended by the manufacturer.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Manufacturer's Field Reports: Indicate that installation is complete and system performs according to specified requirements.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and Federal Communications Commission.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience

C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

D. Installer Qualifications: Authorized installer of specified manufacturer

E. Products: Listed, classified, and labeled as suitable for the purpose intended.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 CLOSEOUT SUBMITTALS

A. Division 01– General Requirements

B. Project Record Documents: Record actual locations of speakers, control equipment, and outlets for input/output connectors.

C. Operation Data: Include instructions for adjusting, operating, and extending the system.

D. Maintenance Data: Include repair procedures and spare parts documentation.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.9 COORDINATION

A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.

B. Coordinate installation of wall mounted speakers with installation of clocks, described in Section 27 5313.

1.10 WARRANTY

A. Contractor’s Warranty: Warranty the installation to be free of defect for a period of one (1) year.

B. Equipment Warranty: Each piece of equipment shall carry a five (5) year manufacturer’s warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. BASIS OF DESIGN: Vocia by Biamp.
2. Substitutions: not allowed.

2.2 OVERHEAD PUBLIC ADDRESS SYSTEM COMPONENTS

A. Supply and install paging speakers as follows:
1. 8” round speakers shall be provided in areas with dropped ACT ceilings,gypsum ceilings, and panel ceilings.
2. In areas without ceilings, provide surface mounted overhead speakers.

2.3 LOUDSPEAKERS

A. Ceiling Speakers:
1. Product Description: 8 inch cone speaker with integral line matching transformer.
2. Power Rating: 15 watts maximum, power taps of 0.5, 1, 2 & 5 watts.
3. Frequency Range: 50 to 18,000 Hz.
4. Magnet: 5 ounce ceramic magnet and1 inch voice coil.
5. Provide with ceiling backbox with sound deadening material and tile bridge for mounting in ACT ceiling.
6. Ceiling grille shall have a white finish.
7. Speaker shall be Atlas Sound FD series or approved equal.

B. Surface Mounted Speakers:
1. Same as Paragraph A ceiling speaker with metal backbox and square, white baffle.

2.4 AMPLIFICATION AND CONTROL EQUIPMENT

A. Paging System Amplifiers:
1. The networked amplifier shall be designed exclusively for use with Biamp Vocia® systems. The amplifier shall support 8 channels of 150 Watts per channel and 70V or 100V constant voltage outputs. The amplifier shall provide control data and digital audio over CobraNet®. The amplifier shall provide dual Ethernet ports for redundant network connection. The amplifier shall have 100-240V AC power supply and dual 48V DC input. The amplifier shall provide front panel LED identification of amplifier failure, signal present, clip present, fan stuck rotor fault, temperature fault and provide additional software monitoring features including speaker line fault monitoring. The amplifier shall be rack mountable (2RU) and feature software-configurable signal processing including volume control, filters, compressor/limiting, delay, speaker equalization and output sensitivity. The amplifier shall support extended audio delay of up to 32 seconds per channel. The amplifier shall be Class-D. The amplifier shall support channel-to-channel and chassis-to-chassis failover. The amplifier shall be CE marked, UL listed and shall be compliant with the RoHS directive. Warranty shall be five years. The amplifier shall be the Vocia VA-8150CV.

B. Paging System Audio Input Device:
1. The audio input device shall be designed exclusively for use with Biamp Vocia® systems. It shall be rack mountable (1RU) and provide audio and control via CobraNet®. It shall receive Power over Ethernet (PoE) utilizing a single (CAT5)

network cable to a rear panel RJ-45 connector. The audio input device shall provide four sets of dual RCA connectors plus removable terminal block connectors for line-level inputs, two microphone/line inputs with phantom power, four paging inputs, six CobraNet outputs, four control inputs, and four control outputs. The input device shall provide local digital audio signal processing and local storage of configuration data. The input device shall indicate signal and clip with LEDs on the front panel. The input device shall be UL listed, CE marked and shall be compliant with the RoHS directive. Warranty shall be five years. The input device shall be a Vocia VI-6.

C. Paging System Message Processor:
1. The message processor shall be designed exclusively for use with Biamp Vocia® systems. The processor shall be rack mountable in one rack space (1RU) and shall support advanced paging functionalities such as recorded message storage and playback, system configuration storage, inter-world support, event scheduling, time server support, storage of logged system data, VoIP triggered paging, email notification, and remote third party control capability. The processor shall feature a status LED and separate ports for TCP/IP Control and CobraNet®. The message processor shall be CE marked, UL listed and shall be compliant with the RoHS directive. Warranty shall be two years. The message processor shall be a Vocia MS-1e.

D. Desktop Paging Station:
1. The desktop paging station shall be designed exclusively for use with Biamp Vocia® systems. The desktop paging station shall provide paging audio and control data via CobraNet®, and receive Power over Ethernet (PoE) utilizing a single (CAT5) network cable to a bottom panel RJ-45 connector. Ten buttons shall be provided on the front panel for recalling page codes with optional preambles. Multiple desktop paging stations may be connected to a Vocia system by means of Ethernet switches. Four software configurable priority paging levels shall be available. The desktop paging station shall include override, store and forward, and lock-out capabilities. Each desktop paging station shall provide local digital audio signal processing, local storage of configuration data and preambles. Desktop paging stations shall have a backlit LCD screen, PIN code accessibility and a gooseneck cardioid microphone. The desktop paging station shall be CE marked and shall be compliant with the RoHS directive. Warranty shall be five years. The desktop paging station shall be a Vocia DS-10.

E. Wall Mount Paging Station:
1. The wall-mounted paging station shall be designed exclusively for use with Biamp Vocia® systems. The wall-mounted paging station shall provide paging audio and control data via CobraNet®, and receive Power over Ethernet (PoE) utilizing a single (CAT5) network cable to a rear panel RJ-45 connector. Ten buttons shall be provided on the front panel for recalling page codes with preambles. Multiple wall-mounted paging stations may be connected to a Vocia system by means of Ethernet switches. Four software configurable non-emergency priority paging levels shall be available. The wall mounted paging station shall include page priority override, store and forward, and lock-out capabilities. Each wall-mounted paging station shall provide local digital audio signal processing, local storage of configuration data, and preambles. Wall-mounted paging stations shall possess a backlit LCD screen, PIN code accessibility, and a high-quality, noise-cancelling handheld microphone. The wall-mounted paging station shall be CE marked and shall be compliant with the

RoHS directive. Warranty shall be five years. The wall-mounted paging station shall be a Vocia WS-10.

2.5 ACCESSORIES

A. Equipment Rack: Floor mounted equipment rack. Dedicated rack for equipment provided by the Div. 27 Telecommunications Contractor.

B. Managed POE Layer 3 Ethernet Switch:
1. Layer 3 managed switch with OVCR | 24 x 1G, 16 x POE+, 245W, 2 x 10G SFP+
2. Variable fans provide quiet cooling to protect components, and enhanced cooling will activate in warmer temperatures.
3. 19-inch rack mount.
4. Three-year warranty.

2.6 WIRE AND CABLE

A. Speaker Cable: Supply and install cable between head-end equipment and speakers as indicated on the drawings.

B. Plenum Cable for Speaker Circuits: Unless otherwise noted on drawings, provide 16 AWG copper, 4 conductor, 300 volt insulation, rated 200 degrees C, paired conductors twisted together shielded and covered with a nonmetallic jacket; suitable for use for Class 2 circuits in air handling ducts, hollow spaces used as ducts, and plenums.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mounting Heights:
1. Wall mounted interior speaker: 6” below ceiling/structure unless otherwise noted on drawings.
2. Wall mounted exterior speaker: 10 feet above finished grade unless otherwise noted on drawings.

C. Splice cable only in accessible junction boxes or at terminal block units.

D. Install input circuits in separate cables and raceways from output circuits.

E. Leave 18 inches (300 mm) excess cable at each termination at paging station, volume pad, and other system outlet.

F. Provide protection for exposed cables where subject to damage.

G. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure for ceiling suspension system. Include bridle rings or drive rings.

H. Use suitable cable fittings and connectors.

I. Install equipment in racks in location shown; arrange to provide adequate ventilation and access.

J. Ground and bond equipment and circuits in accordance with Section 26 0526.

K. Configure the paging system with an all-call with priority override.

L. At each speaker location, form a four (4) foot coil of slack cable prior to each termination point.

3.2 ZONING

A. Public address speaker cabling will originate in the head-end rack (as indicated in drawings) and shall be wired for the zones indicated on the drawings and in Appendix A.

3.3 TESTING

A. Upon completion of the system installation, provide walk-through with Owner's representative in each space with public address system speakers. Demonstrate speaker operation in each room using a similar test signal. Provide final volume adjustment of speakers in each space per Owner's direction.

B. Upon completion of the system installation, align, adjust and balance the system. Determine that the system conforms to the requirements of the Drawings and specifications. Correct all deficiencies and replace malfunctioning or damaged items. Repeat testing until all materials and equipment perform satisfactorily and the system requirements are achieved.

C. Provide a written record of test results to the owner within 10 days of the completion of these tests.

D. Provide all necessary test equipment required for proper facilities testing as outlined below. Adjust levels, frequency attenuators, and matching devices to achieve system performance.

E. Impedance and Phase
1. Check all speaker line paths for proper polarity, make all lines uniform.
2. Measure and record all installed speaker lines, at audio equipment rack, for proper impedance. Document all measurements.
3. Check for proper polarity of all installed speakers, or speaker components.
4. Make any and all required changes to provide correct operation of above.

F. Hum and Noise
1. All Hum and Noise shall be inaudible under normal operating conditions. Corrections must be completed prior to any further testing.

G. Buzzes, Rattles, and Distortion
1. The sound system shall be free of any rattling, mechanical noises, or distortion caused by improper installation. In addition, if under testing it is discovered that external noises are cause from other trades related to this installation or not, it must be brought to the attention of the owner or owner's agent.

H. Acoustical Measurements
1. A Real Time Audio Spectrum Analyzer shall be used with a pink noise source to complete the required testing. A field technician trained in use of this machine is required. All acoustical testing shall be completed after all interior finishes have been done.
2. Frequency Response shall be flat from 60 Hz to 4K Hz + or – 4 dB including no peaks outside of this parameter. Roll off above the outlined range shall be at 3 dB per octave from the 4K Hz to 12.5K Hz. The Real Time Analyzer shall be placed in a minimum of 6 locations to comply with above frequency curves.
3. Coverage shall be uniform. Using a pink noise source, measurement shall be taken at the above 6 locations and at an additional 6 random points. Level shall be uniform within 6 dB.

I. Listening Test
1. May include surveys and subjective testing of intelligibility at random locations under operating conditions. Testing will include live voice quality, recorded speech playback, program playback, and playback of locally recorded program within system.

3.4 DOCUMENTATION

A. Provide copies of all manuals and two (2) sets of as-built documents, in hard copy and electronic format. As-built documentation shall include location and types of hardware provided and installed as well as the interconnection of each device.

3.5 TRAINING:

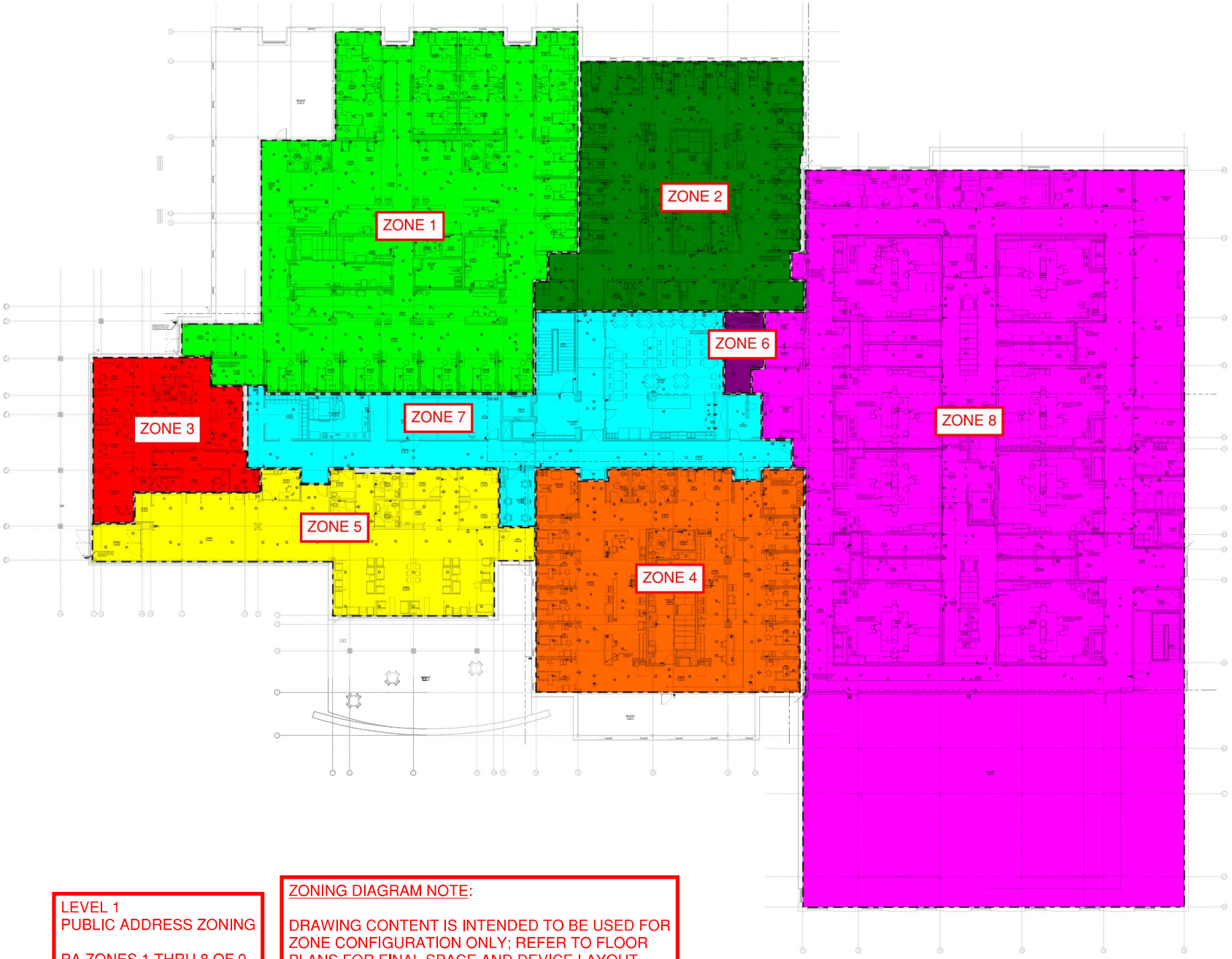
A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.

B. Provide training to personnel selected by the Owner on operation and basic maintenance of all systems and equipment.

C. Include **8 hours** of training Owner’s staff.

END OF SECTION

Appendix A
Public Address System Zones

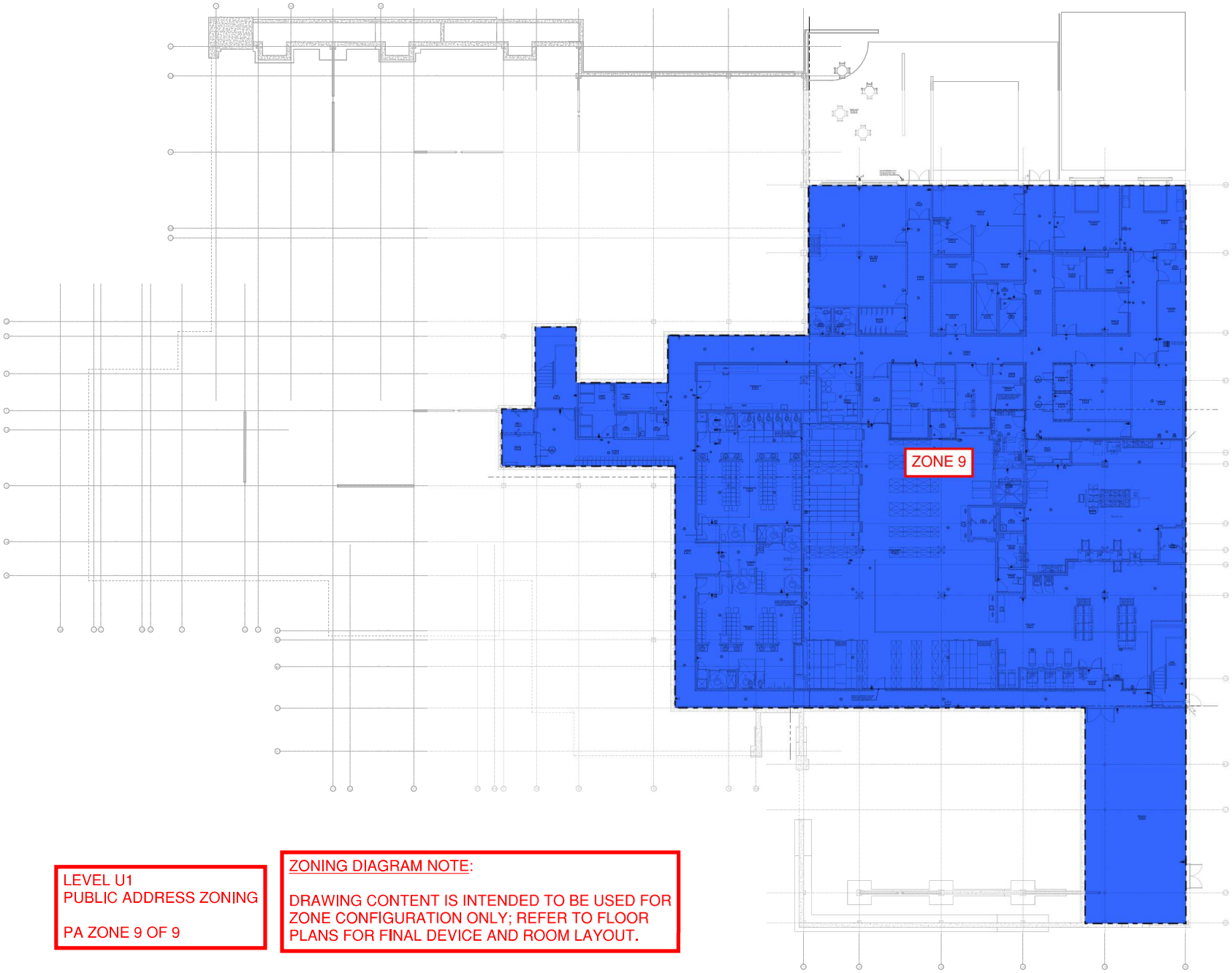


LEVEL 1
PUBLIC ADDRESS ZONING

PA ZONES 1 THRU 8 OF 9

ZONING DIAGRAM NOTE:

DRAWING CONTENT IS INTENDED TO BE USED FOR ZONE CONFIGURATION ONLY; REFER TO FLOOR PLANS FOR FINAL SPACE AND DEVICE LAYOUT.



LEVEL U1
PUBLIC ADDRESS ZONING

PA ZONE 9 OF 9

ZONING DIAGRAM NOTE:

DRAWING CONTENT IS INTENDED TO BE USED FOR ZONE CONFIGURATION ONLY; REFER TO FLOOR PLANS FOR FINAL DEVICE AND ROOM LAYOUT.

SECTION 275129

EMERGENCY 2-WAY COMMUNICATION SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Section includes a complete emergency call system, including master station, call stations, wiring and accessories.

B. Related Sections:
1. Section 260553 – Identification for Electrical Systems.
2. Section 270529 – Hangers and Supports for Communications Systems.
3. Section 270533 – Conduit and Backboxes for Communications Systems.
4. Section 270553 – Identification for Communications Systems.

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. All system components, where applicable standards have been established, shall follow the recommendations of the Underwriters' Laboratories and the National Electrical Code, and must bear the UL label.

C. The system shall comply with the Americans with Disabilities Act sections 4.3.11.4 and 4.3.11.5.

1.4 SYSTEM DESCRIPTION

A. The Contractor shall furnish and install an emergency call system complete including, but not limited to, outlet boxes, conduit, wiring, telephones, Master Station, and Area Stations, and all other equipment necessary to provide a complete and operating Emergency Call System. Equipment furnished under this section shall be the standard product of a single manufacturer.

B. The base station is to be located at a central control point in the lobby adjacent to the fire alarm annunciator or as indicated by the local authority having jurisdiction.

C. Call station phones shall be located at the elevator lobbies on all floors above the level of egress as indicated on the drawings.

D. The base station must be capable of handling a minimum of five (5) call station phones. Visual indicators on the base station allow rescue personnel to know which call station phone needs assistance. The base station must allow rescue personnel to speak to all elevator lobby phones or individual elevator lobby phones.

E. The emergency communication hardware shall comply with the Americans with Disabilities Act (ADA). The call station phones shall have the ability to be programmed with up to 5 emergency phone numbers (base station counts as first number). Upon activation of the emergency push button, a call will be automatically placed to the base station. If no one answers at the Base station, the call station phone must dial a secondary location outside of the building to activate two-way off-site person to person voice communications.

1.5 SUBMITTALS

A. Division 01 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate cable routing and connections.

C. Product Data: For each item of equipment.

D. Manufacturer's Installation Instructions.

E. Project Record Documents: Accurately record actual locations of devices and wiring.

F. Operation Data: Include instructions for routine operation of master and remote stations.

G. Maintenance Data: Include instructions for minor troubleshooting, preventive maintenance, and cleaning.

H. Submit project-specific riser diagram with locations and quantities of speakers and head-end devices.

I. LEED Submittals: Provide manufacturers' or third-party certification of testing to and compliance with the California Department of Public Health (CDPH) Standard method v1.2-2017, that includes the following information:
1. The exposure scenario used to determine compliance.
2. The range of total VOCs after 14 days, measured as specified in the CDPH Standard Method v1.2:
3. 0.5 mg/m^3 or less;
4. Between 0.5 and 5.0 mg/m^3; or
5. 5.0 mg/m^3 or more
6. Laboratory accreditation under ISO/IEC 17025.
7. Claims of compliance for wet-applied products must state the amount applied in mass per surface area
8. Provide MSDS or other manufacturer documentation with disclosure of VOC content for all wet-applied products.
9. Complete "LEED Materials Documentation Sheet" with IEQc2 information for adhesives/sealants installed within the waterproofing membrane.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this Section with minimum three years of documented experience.

B. Supplier Qualifications: Company authorized by manufacturer and specializing in supplying products specified in this Section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in installing the products specified in this Section with minimum three years documented experience.

D. Products: Listed, classified, and labeled as suitable for the purpose intended.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 CLOSEOUT SUBMITTALS

A. Division 01 – Execution and Closeout Requirements: Requirements for submittals

B. Project Record Documents: Record actual locations of area stations, master stations, relay cabinets and power supplies.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.9 COORDINATION

A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.

1.10 WARRANTY

A. Contractor's Warranty: Warranty the installation to be free of defect for a period of two (2) years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Emergency 2-Way Communication System:
1. Rath SmartRescue (Basis of Design)
2. Cornell
3. Housing Devices
4. Substitutions – See Division 1 – Product Requirements.

2.2 CONSTRUCTION:

A. The base station shall have a steel backbox and powder coated steel housing, for flush mounting, red coil cord, red emergency handset, be 120vac powered and include a rechargeable battery to maintain backup power for a minimum of 4 hours of talk time.

B. Provide battery backed-up power supply adequate to power the base station and up to five (5) call station phones.

C. The base station must include connections for up to two (2) elevator machine room phones.

D. The call station phones shall include a steel backbox and brushed stainless steel faceplate.

E. The call station phones must be in full compliance with Americans with Disabilities Act (ADA). Call station phones require a hands-free speakerphone with an LED to indicate status of call.

F. The call station phones must allow the programming in of a specific voice message indicating the location of the phone.

G. The call station phones must be programmable to check the status of the incoming telephone line every 10 minutes up to every 23 hours.

H. The base station must provide an audible and visual indicator that an call station phone has been activated.

2.3 Mounting:

A. The base station is to be flush mounted on a wall.

B. Call station phones shall be flush mounted on a wall.

2.4 Electrical:

A. The base station is to be powered by 120vac when used with supplied step down power supply.

B. Call station phones are to be powered by the central power supply at the base station.

C. Call station phones must have a battery backup capable of providing up to 4 hours of electrical backup in case of building power failure

D. Base station must have a battery backup capable of providing up to 4 hours of electrical backup in case of building power failure.

E. System shall be in compliance with all state and local electrical codes.

2.5 Communications:

A. Call station phones shall be an ADA compliant and vandal resistant speakerphone.

B. The base station must allow for calls to be placed on analog, digital, or VoIP communication lines.

C. Call station phones shall be hands-free and be a push-button-once to talk system. Once the button has been pushed, the call station phones will call the base station. If no answer at the base station, it will automatically call pre-programmed emergency

numbers. The call station phones must be capable of being programmed with up to 5 emergency numbers (base station counts as first number).

D. Call station phones shall have location message capability. Call station phones must include a minimum 18 second recordable message, programmable to play 1 time or continuously until interrupted. Call station phones shall notify called party of the location of the elevator upon receipt of call.

E. Call station phones shall be capable of allowing the called party to replay the location message if necessary to ensure an understanding of the call station location.

F. If the building location does not have a 24/7 attendant on duty, the call station phones must dial a location outside of the building to activate two-way off-site person to person voice communications.

G. Once a call has been made (button pushed), the call can only be terminated by the called party.

H. Call station phones must have a red LED that will light up upon push of the button. The light shall be a solid color when the call station phones are activated, and will flash when call has been answered.

I. The call station phones must be capable of being programmed and re-programmed on-site and remotely.

J. LEED Requirements:

1. For field applications that are inside the weatherproofing membrane: Adhesives/sealants must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario. The default scenario is the private office scenario.
2. All adhesives/sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.

2.6 Standard Base Station features:

A. Flush or surface mount.

B. Operating temperature of between -40˚F to +150˚F (-40˚ to + 65˚ C).

C. All or individual elevator call.

D. Battery backup.

2.7 Standard Call Station Phone features:

A. Five number programming.

B. Operating temperature of between -40˚F to +150˚F (-40˚ to + 65˚ C).

C. Location message.

D. Telephone line verification.

E. Battery backup (4 hours).

F. On-site or remote programmable.

G. 120vac or 24vac/dc power.

H. EEPROM memory to protect programming.

2.8 Graphics:

A. Base Station must include wording identifying the number of each Elevator Phone, instructions on how to operate the Base Station and light an LED when a particular Elevator Phone has been activated.

B. Call station phone wording must include “Emergency Phone”, the International Phone Symbol, and raised Braille lettering.

2.9 BATTERY BACKUP SYSTEM

A. Model: 2500-PWR24U or approved equal.

B. Provide a battery backup system that distributes continuous power to the Area of Refuge Call system in the event of a power failure.

C. The battery backup system shall monitor for:
1. AC power failure.
2. AC and DC surge suppression.
3. No/low battery indications.

D. The battery backup system shall include:
1. Two (2) 12VDC sealed lead-acid batteries (sized as required for min. of 4 hours talk time with all stations active).

E. Ratings:
1. Input voltage: 120VAC.
2. Output: 8.5 A @ 243 VDC.
3. Full operation capability: 4 hours.

F. System shall also include integral amplifier that processes audio signaling for the entire system:
1. Output: 5W.
2. Voltage: 24 VDC.

G. The Battery backup system shall be mounted in a separate enclosure. Location shall be wall mounted above an accessible ceiling at the base station location.

2.10 CABLING

A. All cable shall be as recommended by the manufacturer or an approved equivalent. All Area Station wiring must be home run with individually jacketed cable.

B. All cables run in underground conduits must be suitable for wet locations and appropriately grounded as per EIA and NEC recommendations. See wiring diagrams for details.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as shown on Drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Complete system shall be installed in strict accordance with manufacturer's recommendations.

C. All wiring shall be installed in raceways where routed through ceiling areas.

D. Base station and call station phone mounting shall be in accordance with the ADA.

E. Provide all necessary programming for a complete system, including programming of recorded voice messages and dial out numbers.

F. System wiring shall be in accordance with good engineering practices as established by the EIA and NEC. Wiring shall meet all established state and local electrical codes. All wiring shall test free from shorts and grounded as specified.

G. Coordinate with the Authority Having Jurisdiction and install fireman’s locking mechanism and cylinder.

3.3 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements, for additional requirements.

B. Provide the services of the manufacturer's technical representative to make final connections to unit; prepare and start systems; and perform field inspection and testing.

C. Perform operational test on completed installation to verify proper operation.

D. Replace equipment, components, and wiring to eliminate audible noise, clicks, pops, or hum when system is in standby or operation.

3.4 ADJUSTING

A. Adjust controls and configuration switches for operation as indicated.

3.5 DOCUMENTATION

A. Provide copies of all manuals and two (2) sets of as-built documents, in hard copy and electronic format. As-built documentation shall include location and types of hardware provided and installed as well as the interconnection of each device.

3.6 TRAINING:

A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.

B. Provide training to personnel selected by the Owner on operation and basic maintenance of all systems and equipment.

C. Include **2 hours** of training Owner’s staff.

END OF SECTION

SECTION 275223

NURSE CALL SYSTEM

PART 1 GENERAL

1.1 REQUIREMENTS

A. The work to be provided under this section consists of furnishing and installing state-of-the-art microcontroller-based Nurse Call Systems.

B. The Nurse Call components described herein are based on equipment manufactured by as manufactured by Ametek-Rauland Borg Corporation, Mt. Prospect, Ill. The specific system whose functions and features are specified is the Responder 5 system Local representation must come from a factory-authorized systems integration firm, which shall be required to provide proof that it:
1. Possesses at least eight (8) years of large-scale Nurse Call installation experience.
2. Operates from a commercial office with a dedicated service facility, within 150 miles of South Burlington, Vermont.

C. To ensure that parts, service, and technical data are available for the long term, and to ensure that there is a single reputable source of responsibility for all components, the systems shall be comprised of standard products of a single manufacturer.

D. It shall be the Contractor's sole responsibility to supply all materials and labor needed to create complete, working, and stable systems within this specification's intent, as judged by the Engineer and Owner. The Owner will not pay any additional charges above the bid amount to render the systems 100% operational in accordance with manufacturer's specifications, and in accordance with the functional intent of these specifications.

E. The final installation must be in full and total compliance with manufacturers' published wiring requirements for the specific equipment approved. The Contractor shall not put the Owner at risk by implementing ideas or theories with regard to cable conductor requirements and configurations, which are in any way contrary to standard documentation. Furthermore, individual conductor colors must exactly match those colors indicated on the manufacturer’s standard drawings. Pursuant to this vital requirement, submittals must include complete information on proposed cable. Installed wiring shall subsequently be field-verified by the Engineer.

F. All equipment shall be listed for UL 1069 Standards for Hospital Usage.

1.2 SYSTEM OVERVIEW: PARAMETERS & FEATURES

A. Provide a complete working Audio Visual -Nurse Call Network based upon the specification outlined here to include all necessary devices that provide the functions listed in this specification. This facility will be referenced as the OWNER in this specification. To ensure standardization across the Owner’s nurse call systems’, the nurse call network shall be Responder 5 as manufactured by Ametek-Rauland Borg Corporation, Mt. Prospect, Ill.

B. If an operational function is specified that requires hardware or software to complete that specific function, then consider that software or hardware part of this specification. The

cost of any omissions of software or hardware necessary to complete all operational functions outlined in this specification shall be borne by the contractor providing this system.

C. All Nurse Call Network devices shall be ANSI/UL-1069 listed. This includes routers, hubs, switches, and room control devices. The nurse call network shall be a United States Food and Drug Administration (FDA) Registered Class II (or higher) medical device and the system's manufacturer shall be an FDA Registered Operator. Field wiring shall be CAT 6 cable, control wiring for power distributions and very long runs, and utilize an optional fiber backbone (when distances exceed normal Ethernet limitations). All station equipment shall use plug on connectors and all switches, routers and controllers shall utilize standard RJ-45 modular connections. All remote devices utilizing standard structured cabling shall be capable of PoE (Power over Ethernet) or power supplied within the CAT 6 cable jacket. Systems which require separate DC power to devices, remote power supplies, or heavy DC wiring to each individual room shall not be accepted. Wiring shall be capable of either being installed in conduit or cable trays, where shown on the plans. Nurse Call cabling may be run along with other low voltage and data cables where permitted by code. Nurse Call cabling to be separated out from any high voltage AC or DC wiring that exceeds 90 volts, or which violates any national or local electrical code.

D. The system shall be capable of interconnecting with the facility's LAN (Local Area Network). This connection shall be minimal and utilize only one Ethernet 100 Mbps (or optionally 1 Gb) connection to accomplish all information exchange.

E. The OWNER shall provide one VPN connection. One VPN is for the servicing contractor to diagnose any maintenance issues and to maintain the system offsite. Diagnostic software shall be web based and permit e-mail notification of high level alarms. All software applications shall be HIPAA (Health Insurance Portability and Accountability Act) and PIPEDA (Personal Information Protection and Electronic Documents Act) compliant and shall allow for resident name aliases and alternative display methods.

F. Overall Nurse Call Network shall utilize VoIP communications between the nurse consoles, wireless telephones, and controllers. Any nurse call console must be able to answer any resident call placed in the network. The communication standard shall be SIP protocol when wireless telephones are integrated. The OWNER will not be providing any analog ports to the nurse call network. As part of this contract, the OWNER will either supply or establish that there is a telephony call network which supports the SIP protocol within the OWNER'S facility. Systems requiring digital to analog converters will not be accepted.

G. The Network shall be capable of backward compatibility to prior generation of Nurse Call system stations and corridor lights by same vendor via a change in headend equipment only. Patient stations, LED corridor lights, and cabling runs to patient rooms shall not require new cabling.

1.3 REFERENCES

A. Underwriter's Laboratories ANSI/UL-1069 Standard for Safety for Hospital Signaling and Nurse Call Equipment, current release

B. Canadian Standards Association

C. National Electrical Code

D. National Fire Protection Association (NFPA) 70 and 99

E. U.S. Dept. of Labor / Occupational Safety and Health Administration

F. State Hospital Code / Joint Commission of Hospitals – Nurse Call Requirements

G. National Electrical Manufacturers Association (NEMA) installation standards**.**

1.4 SCHEDULING

A. It is the responsibility of the contractor to coordinate all work with the other trades for scheduling, rough-in, and finishing all work specified. The OWNER will not be liable for any additional costs due to missed dates or poor coordination of the supplying contractor with other trades.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Shop Drawings: Indicate dimensioned drawings of the Nurse Call System components and accessories.
1. One Line Diagram: Indicating system configuration, wiring, controllers and number and type of devices.
2. Include typical wiring diagrams for each component.
3. Floor Plan Layout Drawings: Manufacturers symbols are acceptable, provided that symbology between engineer’s device legend and manufacturers symbols are cross-referenced.

C. Product Data: Submit manufacturer’s standard product data for each system component. This shall include, but not be limited to: ratings, configurations, dimensions, sensor coverage ranges, colors, service condition requirements, and installation features.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Throughout progress of the Work, maintain an accurate record of changes in Contract Documents. Upon completion of Work, transfer recorded changes to a set of Project Record Documents.

B. The floorplans shall be submitted in digital format to include the following:
1. Each device specific locations with UL labels affixed.
2. Conduit locations.
3. Each interface and equipment specific location.
4. Head-end equipment and specific location.
5. Wiring diagrams.
6. Labeling and administration documentation.

C. Warranty certificate.

D. System test results.

1.7 WARRANTY

A. The supplying contractor shall provide a warranty on the system which shall include all necessary labor and equipment to maintain the system(s) in full operation for a period of one year from the date of acceptance.

B. Manufacturer shall provide, free of charge, product firmware/software upgrades throughout the 1 year warranty period for any product feature fixes.

C. In addition, the equipment (parts) warranty for all core system components including control / switching equipment, power supplies, patient stations, sub- stations, and nurse consoles shall extend to a total of at least five (5) years.

D. After the acceptance of the system(s) service shall be provided on the following basis:
1. Emergency Service: Provided 24 hours a day. When a total or catastrophic failure of equipment is reported to the contractor, within 3 hours of noticiation, a service person will be on site. (example – a controller or nurse console failure is catastrophic failure).
2. Routine Service: Provided within 4 business hours of notification during normal facility operating hours. When a minor failure of equipment is reported, a service person will be on site within 24 hours of notification. (example – peripheral equipment failure which affects a single patient room).

1.8 CENTRAL EQUIPMENT SPECIFICS

A. All central equipment shall be located as indicated and directed, in the telecommunications rooms.

B. Sufficient station expansion cards and power provisions shall be provided to cover all current needs, plus a minimum of 20% spare station capacity at each Central Equipment cabinet installed.

C. Each outbound dome light circuit line shall likewise be laid out to allow for a minimum of 20% additional station capacity, without the need to install new homerun wiring.

D. The central equipment server shall be installed in a cabinet, wall mounted as directed in the designated equipment room. The cabinet shall include all necessary provisions for power, cable harnessing, and cooling.

E. All other necessary labor, equipment, cable, software, electrical hardware, and electronic components shall be provided as needed in order to conform to these specifications.

PART 2 PRODUCTS

2.1 NURSE CALL NETWORK WIRING

A. All Nurse Call Network wiring shall be CAT 6. Plenum wire shall be used in open areas and standard CAT 6 within conduit. System shall be capable of injecting DC power into A CAT 6 run, for additional rooms, or long runs, by running a separate DC cable pair to a remote location.

2.2 NURSE CALL CONTROLLERS

A. The Nurse Call controller, switches, power supplies shall be housed in a lockable cabinet, sized for the equipment required at the controller location. Cabinet shall be provided by the same manufacturer as the equipment.

B. Controller features:
1. Non-blocking, duplex communications between consoles and rooms, sub stations and bed management stations.
2. CAT 6 wiring standard utilizing PoE (Power over Ethernet) between console and nurse call controllers and local wiring to power room station equipment and dome lights.
3. VoIP audio to Nurse Call Network, VoIP Nurse Console, VoIP staff terminal, wired or wireless phones via SIP protocol. VoIP digital audio stream out to rooms without IP overhead signaling.
4. Up to 96 corridor lights can be operated with a single controller**.**

C. Controller must be life safety grade meaning that it shall not require regular rebooting for continued basic functions of system and it shall be possible for controller to act as a stand alone controller should loss of network communication occur. Personal Computers may not be used for this purpose. PCs will only be allowed outside of the UL-listed nurse call network on the customer supported LAN.

D. Nurse call main controller(s) are connected to the hospital's LAN via Ethernet switches. The nurse call servers also connected to the hospital's LAN are running specialized software for using hospital data resources and telephone communications resources.

2.3 VoIP NURSE CONSOLES MASTER STATION

A. Furnish as shown on plans, a UL-1069 listed VoIP nurse console capable of the following functions:
1. Full duplex audio
2. Color display
3. 12 or 24 hours time display and synchronization to hospital standard network time from the nurse call gateway server including any daylight savings time changes supported by the network.
4. Display up to 3 incoming calls each with an individual elapsed timer which increments time since call was placed. Also provide the ability to scroll to see more incoming calls.
5. Power over Ethernet powered connection to UL-1069 listed Ethernet controller. No local power supplies required.
6. Choice of hands-free duplex communications through built in speaker and separate microphone or private handset conversation.
7. Ability to create up to 32 soft keys, user-configurable, with 4 buttons, 8 screens deep.
8. Console shall be interactive with an associated PC workstation (user provided) without the necessity of any interconnection to the PC. The work process relationship shall be software defined through the network connections.
9. Optional tone/mute of calls in progress.
10. Ability to block all nurse call loudspeaker paging to facilitate a low noise patient environment. Password protection can be enabled to only allow authorized access to audio paging.
11. Ability to swing an individual room or any group of rooms by touching one labeled touch point. Room(s) and consoles may be located anywhere within hospital nurse/patient communications network.

12. Console can be programmed to be the receiver of any call that is not answered by another console, or can be programmed to receive any call from a console that has failed or has been unplugged, or otherwise not receiving the call (call orphaning).
13. Ability to dial through built in key pad.
14. Self-contained unit which shall not occupy more than 88 square inches of desk space and is desk or wall-mountable.
15. Support manual Staff Follow functions. When Staff Follow is enabled, call-tones for a prescribed area will automatically be forwarded to the room station speaker where staff members are located. Staff location may be determined manually by entering the room number into the console or automatically using staff register stations or registration via RTLS. Pressing the call button on that station shall silence the tones. When a new call is place, the tones shall automatically be restored.

2.4 STAFF TERMINAL (MINI MASTER STATION)

1. The VoIP staff terminal can function as workflow station or as a mini master station.
2. The VoIP staff terminal is configurable to meet staff needs and includes:
   a. RJ45 connector with CAT 6 cable communications to the controller.
   b. Twelve configurable touchpoints.
   c. Hands free audio.

2.5 PC CONSOLE DISPLAY

A. Provide a PC console display on any networked OWNER provided PC that meets the system manufacturer's minimum specifications, whether it utilizes touch screen or standard mouse control. When a PC is "associated" with a VoIP console described previously, it shall have full interoperability to provide user with easy to follow on screen functions, such as display of call priority, room and patient information. Selecting a touch point or by mouse click shall provide an automated service reminder. While in audio contact with the patient, an enriched display shall show all user defined display information, such as caregiver assigned, and pertinent patient information.

B. The following additional functions shall be provided at each one of these users' screens:
   1. Full display of all calls, including corridor light color sequence.
   2. Complete electronically generated census of patients showing assigned caregiver, current patient needs as sent by service reminder process, time patient has been waiting for call answering, or need, list of caregivers on duty and staff location.
   3. Ability to text message to any single individual, group of users, or all users, a text message to a pager or wireless phone display.
   4. Ability to display calls in a centralized display format (i.e. Centralized Code Blue display).
   5. Ability to display and route calls in a de-centralized workflow environment.
   6. Ability to display all staff information, staff status, wireless extension and their location.

2.6 ENHANCED SINGLE PATIENT STATION

A. Each patient station shall be capable of the following functions:
   1. Separate speaker and microphone for full duplex audio. Entertainment audio to be muted when intercom in use.

2. One DIN pillow speaker receptacle per bed that shall have a tilt design, with automatic release of pillow speaker plug when pillow speaker cord is pulled at any angle.
3. One universal 1/4" jack for auxiliary alarm input/call cord per bed. Call priority of these receptacles shall be independent of any other button or receptacle**.**
4. Cancel button shall cancel any call on this station and any other station in room that is programmed for universal room cancel**.**
5. Continuous supervision.
6. Ability to service exchange station "hot" without removing system power or powering down the local controller.
7. Ability to program on a per patient station basis, each bed and entertainment/call cord receptacle to custom call priorities.
8. Two programmable buttons: code blue and staff assist. Optionally these two buttons may be changed to any call process that is selected by OWNER by changing the buttons.
9. Supply where noted for the Enhanced Single Patient Station an optional Clear Button Cover to prevent accidental initiation of the additional programmable buttons. Cover is easy to install and has an easy to lift cover to access the buttons.
10. Unit shall mount in a standard 3-gang electrical box.

2.7 SUB-STATIONS

A. Provide as shown on plans, sub-stations which shall be flush mounted in a single gang box. All sub station cancel buttons will follow the cancel policy as defined in the system configuration. Typically canceling a high priority call can only be accomplished by the station initiating a call, while lower priority calls may be cancelled by any associated station in the room.

B. Individual sub-stations shall be:
1. Pull cord station shall be water resistant with a replaceable PVC pull-cord, and easily cleaned surface. The pull-cord shall have a large, easy to pull plastic "bell" attached. This station may only be cancelable with the room and not cancelable from the nurse console.
2. Pull cord station with Speaker shall have all the capabilities of the pull cord station with call button, and include a built in speaker and microphone for communications with the patient. Although this station trims out to a double gang faceplate, the mounting is in a single gang box.
3. Staff assist/code station: Dual button stations shall be water resistant. The buttons shall be back lit and have the ability for a user defined customized call label corresponding to the 990 call priorities available within the system.
4. Single and Dual call button station can have an optional Clear Cover to prevent accidental initiation of the call buttons. Clear Cover is easily lifted to access buttons and does not cover the Cancel button for easy cancelation of calls.
5. Bed management station shall have four backlight buttons: Transport, Cleaning Needed, Cleaning in Progress, Bed Ready. The buttons will indicate the room condition and alert transportation personnel to this room. When the Transport button is depressed, the transport person assigned to this area receives a wireless message to transport this patient, or alternately, transportation dispatcher
receives an on screen display. Environmental Services staff will receive a wireless message that this bed requires cleaning. Environmental Services and nursing supervisors are alerted to the bed's state. Alternately, customized descriptions can be assigned to this station for specific facility needs. Canceling

an event maybe accomplished by pressing a button a second time, using the cancel button, or by pressing another button in the chain of events.

2.8 DUTY STATION

A. Provide as shown on plans a duty station. Unit shall provide remote annunciation of assigned patient stations and sub-stations via 4 LED's and multiple call tones. Duty station faceplate LED's shall mimic corridor light activity for the assigned nursing area. Also provides two-way duplex intercom to the assigned nurse console(s) through separate speaker and microphone. Call tones generated at duty station must be identical and repeat in synch with tones produced at closest nurse console. It shall be possible to mute the call in tone, without cancelling call. The next call in, assigned to this duty station, will un-mute the station. Muting feature may be defeated in those jurisdictions that do not allow muting of duty station. The duty station shall be capable of being programmed for a specific time that a day/night mode takes place, allowing a volume change to the call-in tones. This feature is required to minimize noise for patients. Unit shall mount in a standard 3-gang electrical box.

2.9 DOME LIGHTS AND DOMELESS CONTROLLERS

A. Provide as shown on plans, the proper type of dome light or domeless controller. Dome lights shall contain four sections, each lighted by a long life, RGB LED capable of producing 7 colors. Each section shall have a diffusion lens which allows for 180 degree horizontal visibility of call lights. The dome lights shall be capable of the following:
   1. All segments of corridor light can indicate a call in any of the following 7 colors: Blue, Red, White, Green, Orange, Yellow, or Pink**.**
   2. Custom call patterns (any combination of light segments, such as all segments blue for code blue).
   3. Flash any single color or strobe the sections of the light in any color pattern.

B. Intelligence in the corridor light and domeless controller shall support up to 16 room devices and allow for the ability of any room station to be associated with any other room in the system. This allows special functions where needed, such as associated call stations and cancelling options, (i.e. door monitoring).

C. Staff registration shall be indicated by a custom color associated with that staff level (i.e. Green = Nurse, Orange = LPN, Yellow = Aide).

D. Domeless controllers shall have all the function of the corridor light, less LED's.

E. In the unexpected event of communications loss with the nurse call controller, corridor lights and domeless controllers shall enter a local room failsafe mode showing all calls in the hallway via the LED indicators.

F. Corridor lights and domeless controllers may be hot-swapped on the room-to-room communication line without the loss of communications to other devices on the local network.

PART 3 EXECUTION

3.1 INSTALLATION & TESTING

A. All cable installed shall match in exact accordance with manufacturer's published requirements, including colors, and shall be plenum rated.

B. Cables in cabinets shall be meticulously labeled and neatly arranged, using professional plastic coated adhesive labels. Proper service loops shall be provided throughout the project.

C. All devices shall be fully tested upon completion of each area. Tests of all functions at each device are required. Written certification of each area as 100% functional shall be provided.

3.2 PROGRAMMING, TRAINING, & DOCUMENTATION

A. Color-coded submittal and as-built drawings of each area shall be provided. Every station, device, cabinet, and all interconnecting cables shall be clearly shown on a scale floor plan.

B. The Contractor shall meet with the Owner to inform them of all programming options, and to leave blank programming sheets that cover all user programmable features on a station by station basis

C. The Contractor shall provide initialization and system programming procedures in exact accordance with manufacturer's instructions.

D. Two additional system re-programming cycles shall be allotted, to cover any programming changes desired by the Owner during the warranty period.

E. After the installation, the Contractor shall provide a comprehensive training program, to familiarize all users with the new equipment in detail. A minimum 6 hours shall be allocated for each system. The program shall be reiterated as required, until the Owner is satisfied that all designated personnel are adequately trained.

F. The Contractor shall supply the Owner with 2 complete instruction manuals in hardcover binders, including complete engineering and service data on all equipment installed. The Contractor shall also supply 10 simplified "user" instruction manuals, with each manual containing basic instructions (with illustrations) for typical user level features.

G. A factory technical training seminar shall be provided to the Owner at no additional cost. This training seminar is held at the Westcall factory on an "as-scheduled due to need" basis and offers a minimum of three days of hands-on training to all hospital engineering and/or bio-medical staff. Hospital personnel have access to this school for the life of the system.

3.3 WIRING

A. Contractor shall terminate all wiring with manufacturer-approved connectors. The use of wire nuts is prohibited.

B. All wiring shall be free from shorts and faults. Wiring shall be UL listed, NEC and NFPA 70, Article 25 approved.

C. Nurse patient communications network wiring shall not be run in the same conduit with other systems (i.e. Class 1 AC power distribution, fire alarm, entertainment systems, lighting controls, etc.).

3.4 DRAWINGS

A. The Electrical Contractor, not the system supplier, shall provide as built drawings of all installed network components and associated wiring on building plans.

3.5 SPARE DEVICES

A. Contractor shall provide the following at project completion to the Owner, at no additional cost:

Qty	Description
2	Enhanced Patient Stations with audio
2	Staff Assistance Stations with Code Blue
3	Dome lights
2	Domeless Contollers
2	Bed Management Stations
6	Audio Call Cords

3.6 ALTERNATES

A. Provide separate price for a two (2) year comprehensive service contract, covering all costs for parts and labor for all repairs needed due to equipment failure for 2 years beyond the date of acceptance.

END OF SECTION

SECTION 275230

REAL TIME LOCATOR SYSTEM

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Supply and install a real time locator system consisting of RF tags, sensors, data collectors, data concentrators and software.

B. Related Sections:
1. Division 01 – General Requirements
2. Section 26 0400 – General Conditions for Electrical Trades
3. Section 27 0529 – Hangers and Supports for Communications Systems.
4. Section 27 0533 – Raceway and Boxes for Communications Systems.
5. Section 27 0553 – Identification for Communications Systems.
6. Section 27 5223 – Nurse Call System

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. Underwriters Laboratories (UL).

C. EIA/TIA 568-B.

1.4 SYSTEM DESCRIPTION

A. Web-based Real time Locator System (RLTS) utilizing staff location badges, radio frequency receivers and infrared receivers, to monitor the location and movement patterns of staff.

B. Input components:
1. Staff badges.
2. Infrared receivers (IR), with focus kits where indicated.
3. Radio frequency receivers (RF).
4. Data collectors.
5. Data concentrators.

C. Features:
1. Interface to Nurse Call System.
2. Interface with data network.

3. Display data on visual displays.

D. The Contractor shall furnish and install all equipment including, but not limited to, outlet boxes, wiring, sensors, collectors, concentrators, enclosures, and all other necessary equipment to provide a complete operating system as indicated with the contract documents. Provide all necessary wall plates, specialty boxes, etc.

E. Contract documents are detailed only to the extent required to show design intent. It shall be understood and agreed upon by the Contractor that all work described herein shall be complete in every detail.

F. Furnish additional items not mentioned herein to meet requirements as specified, to include hardware, rack panels, terminations, and other devices that are required for installation.

G. Labor furnished shall be trained and experienced in telecommunication systems.

H. All equipment unless otherwise specified, shall be new, free from defects, and the best craftsmanship in its class.

I. All manufactured equipment shall be installed as recommended by the manufacturers, or as indicated in their published installation manual.

J. Furnish and install necessary equipment, backboxes, supports and enclosures.

K. Furnish and install all necessary wire.

L. Perform initial programming of system.

M. Perform final programming of system.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Indicate layout of equipment mounted in cabinets, component interconnecting wiring, and wiring diagrams of field wiring to sensors.

C. Product Data: Provide data showing electrical characteristics and connection requirements for each component.

D. Test Reports: Indicate satisfactory completion of each test recommended by the manufacturer.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Manufacturer's Field Reports: Indicate that installation is complete and system performs according to specified requirements.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and Federal Communications Commission.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience

C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

D. Installer Qualifications: Authorized installer of specified manufacturer

E. Products: Listed, classified, and labeled as suitable for the purpose intended.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 CLOSEOUT SUBMITTALS

A. Division 01– General Requirements

B. Project Record Documents: Record actual locations of IR and RF receivers, IR receivers with focus kits, collectors, concentrators, and server.

C. Operation Data: Include instructions for adjusting, operating, and extending the system.

D. Maintenance Data: Include repair procedures and spare parts documentation.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.9 COORDINATION

A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.

1.10 WARRANTY

A. Contractor’s Warranty: Warranty the installation to be free of defect for a period of one (1) year.

B. Equipment Warranty: Each piece of equipment shall carry a one (1) year manufacturer’s warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. BASIS OF DESIGN: Versus by Midmark RTLS Solutions, Inc.
2. Substitutions: not allowed.

2.2 OVERHEAD RLTS COMPONENTS

A. Supply and install:
1. Ceiling mounted IR Receivers.
2. Ceiling mounted IR receivers with focus kit.
3. Ceiling mounted RF sensor.
4. In areas without ceilings, provide surface mount backbox and conduit.

2.3 RECEIVERS

A. IR Receiver:
1. Product Description: Wired IR sensor to receive encoded infrared emitted by Midmark RTLS badges and tags.
2. Power Rating: 255 mW.
3. IR Wavelength: 875 nm.
4. IR Reception Frequency: 455 KHz.
5. Reception angle: 360 degrees on-axis reception.
6. Construction: Polycarbonate housing.
7. Size: 2.75”H x 2.75”W x 1”D.
8. Ceiling Attachment: Spring-steel clip.
9. Accessories:
a. Wired sensor focus kit: allows reception to focus on bed or chair level granularity. Provide where indicated on drawings.
b. Wired sensor bracket.

B. RF Receiver:
1. Product Description: Wired RF sensor to receive encoded radio frequency signals emitted by Midmark RTLS badges and tags.
2. Power Rating: 180 mW.
3. Bandwidth: 800 KHz.
4. RF Frequency: 433.9 MHz.
5. Reception distance: 90 ft. open air.
6. Construction: Polycarbonate housing.
7. Size: 2.75”H x 2.75”W x 1”D.
8. Ceiling Attachment: Spring-steel clip.

2.4 CONTROL EQUIPMENT

A. Sensor Collectors:
1. The collectors accept input from up to 24 IR or RF receivers and converts signals to determine location and transmits data via Ethernet cable to the concentrator. Includes sensor input board and amphenol connector and low voltage, plugin style power supply.

B. Sensor Concentrator:
   1. The concentrator receives data from up to four collectors and accepts input from up to 24 IR or RF receivers and converts signals to determine location and transmits data via Ethernet cable to the data network. Includes sensor input board and amphenol connector and low voltage, plugin style power supply.

C. IR/RF Clearview Badges:
   1. The battery operated badges include a programmable button, operate on lithium coin cell batteries, and transmit with IR wavelength of 875 nm/455 KHz and an RF frequency of 433.92 MHz. Coordinate color selection with owner and provide with badge holder and clip.

D. Badge Storage Cabinet:
   1. Cabinet for storage of badges in a non-active zone to preserve battery life.

E. Reporting Software:
   1. RTLS: Staff location in relation to nurse call activity, call response time, and rounding data.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide protection for exposed cables where subject to damage.

C. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure for ceiling suspension system. Include bridle rings or drive rings.

D. Use suitable cable fittings and connectors.

E. Install equipment cabinets in location shown; arrange to provide adequate ventilation and access.

F. Ground and bond equipment and circuits in accordance with Section 26 0526.

G. At each sensor location, form a ten (10) foot coil of slack cable prior to each termination point.

3.2 Wire and Cabling:

A. Contractor shall terminate all wiring with manufacturer-approved connectors. The use of wire nuts is prohibited.

B. All wiring shall be free from shorts and faults. Wiring shall be UL listed, NEC and NFPA 70, Article 25 approved.

3.3 TESTING

A. Upon completion of the system installation, align, adjust and balance the system. Determine that the system conforms to the requirements of the Drawings and specifications. Correct all deficiencies and replace malfunctioning or damaged items. Repeat testing until all materials and equipment perform satisfactorily and the system requirements are achieved.

B. Provide a written record of test results to the owner within 10 days of the completion of these tests.

3.4 DOCUMENTATION

A. Provide copies of all manuals and two (2) sets of as-built documents, in hard copy and electronic format. As-built documentation shall include location and types of hardware provided and installed as well as the interconnection of each device.

3.5 TRAINING:

A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.

B. Provide training to personnel selected by the Owner on operation and basic maintenance of all systems and equipment.

C. Include **8 hours** of training Owner’s staff.

END OF SECTION

SECTION 27 53 13

CLOCK SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Section includes a wireless clock system.

B. Section includes central clock and program system equipment, indicating (secondary) analog and digital clocks, repeaters, and elapsed time controls.

C. Related Sections:
1. Section 27 0529 – Hangers and Supports for Communications Systems.
2. Section 27 0533 – Conduit and Backboxes for Communications Systems.
3. Section 27 0553 – Identification for Communications Systems.
4. Section 27 1000 – Structured Cabling (for Ethernet cable requirements).

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. Underwriters Laboratories (UL).

C. EIA/TIA 568-B.

1.4 SYSTEM DESCRIPTION

A. Description: Synchronized wireless time System to include master clock system controller, transmitters and wireless (communications) secondary clocks. System establishes time standard signal for:
1. Indicating clocks.
2. Elapsed timer controls for OR digital clocks.

B. Configuration: Synchronized wireless.

C. Equipment and components furnished shall be of manufacturer’s latest model.

D. System shall be installed in compliance with local and state authorities having jurisdiction.

1.5 SUBMITTALS

A. Division 01 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate wiring diagrams and interconnection diagrams.

C. Product Data: Provide for each item of equipment; show specified ratings, colors, finishes, and physical dimensions.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Operation Data: Operating instructions.

F. Maintenance Data: Maintenance and repair instructions.

G. Submit project-specific riser diagram with locations and quantities of clocks and head-end devices.

H. Operating License: Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Engineer prior to operating the equipment. When license is received, deliver original license to Engineer.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and Federal Communications Commission.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

D. Installer Qualifications: Authorized installer of specified manufacturer.

E. Products: Listed, classified, and labeled as suitable for the purpose intended.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 CLOSEOUT SUBMITTALS

A. Division 01 – Execution and Closeout Requirements: Requirements for submittals

B. Project Record Documents: Record actual locations of clocks.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.9 COORDINATION

A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.

1.10 WARRANTY

A. Contractor's Warranty: Warranty the installation to be free of defect for a period of one (1) year.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Sapling (Basis of Design).

B. Substitutions: Not Allowed.

2.2 SYSTEM REQUIREMENTS

A. Ensure clock system components are designed to operate as a wireless clock system and as part of complete system including "fail-proof" design to ensure power interruption does not cause system failure.

B. Ensure system synchronizes all clocks and devices to each other.

C. Ensure system does not require FCC licensing.

D. Ensure system works in 915-928 MHz frequency range.

E. Ensure system uses frequency-hopping technology.

F. Ensure system is capable of correcting clocks immediately upon receipt of wireless signal.
1. Analog and digital clocks automatically correct themselves on receipt of wireless signal.
2. Include built-in closed-loop system in analog clocks capable of allowing clocks to detect position of hands and bring clocks to correct time even if clocks are manually altered.
3. Ensure secondary clocks have diagnostic function capable of allowing user to view how long since clock received wireless signal.
4. Ensure secondary clocks are capable of functional tests of electronics and gears.

G. Ensure each individual product is bench tested at manufacturer's facility.
1. Random testing is unacceptable.

H. Ensure each product is designed, assembled and tested in the United States of America.

I. Location of clocks shall be coordinated with architectural drawings. Finishes, colors, trims and custom graphics shall be selected by the Architect.

J. Program clock as a master unit. Master clock to act as primary clock for time synchronization and scheduling.

2.3 WIRELESS MASTER CLOCK:

A. Master Clock: Conforms to UL and cUL 863.
1. Ensure master clock includes 10 pre-programmed (S)NTP backup addresses.
2. Ensure master clock is capable of receiving (S)NTP time signal via Ethernet.
3. Ensure master clock is capable of receiving digital signals through RS485 connection.
4. Ensure master clock is capable of correcting secondary clocks for Daylight Saving Time
5. Ensure master clock is capable of customizing Daylight Saving Time, in the event of international use or a change in government regulations.
6. Ensure master clock is capable of outputting RS485 signals.
7. Ensure master clock has two clock circuits capable of outputting signals including:
   a. 59 minute correction;
   b. 58 minute correction;
   c. National Time or Rauland correction;
   d. Once a day pulse;
   e. Rauland digital correction.
8. Communications Interface: Ensure master clock system is capable of being programmed remotely through online interface accessible through LAN and compatible with Microsoft Internet Explorer and Mozilla Firefox web browsers.
   a. Ensure interface includes functions as follows:
      1) Allow users to schedule bells and other events;
      2) Display features;
      3) Show IP settings;
      4) Show other master clock settings;
      5) Set time and date;
      6) Download or upload master clock settings;
      7) Configure e-mail alerts for various instances.
9. Display: Two row, 20 character LED and backlit LED display and 2 x 8 inch rubber keypad for operator programming.
10. Optional relays: Include 4 relays to ensure master clock is capable of utilizing 4 zones that can be used for scheduling facility bell system (via PA system).
11. Allow for programming of master clock through 16 button rubber tactile keypad or built-in web interface.
12. Ensure master clock can contain up to 800 events.
13. Ensure master clock can contain up to 255 schedule changes.
14. Clock System: Wireless with transmitter to FCC, Part 15.
   a. Transmitter: Capable of transmitting data to SAL(G) wireless analog and SBL(G) wireless digital clocks, and receiving signal from (S)NTP time server
   b. Automatic bi-annual Daylight Savings Time changes.
15. Ensure master clock has internal battery to save settings and operate internal real-time clock for 10 years.
16. Input Voltage: 85 V AC – 264 V AC, 50/60 Hz.
17. Mounting: Provide with rack mount kit for installation in telecommunications rack.
18. Basis of Design: Sapling SMA 3000 Series.

2.4 REPEATERS

A. Wireless Repeater: Capable of wirelessly transmitting and receiving data and compliant with FCC, Part 15.
1. Input Voltage: 85 V AC – 264 V AC, 50/60 Hz.;
2. Input: RS485. Sapling Wireless Communications;

3. Input source: Master clock or Secondary Sapling Wireless Clock;
4. RF power output: 30 dBM (1 Watt);
5. Frequency hopping technology;
6. Mounting: Wall mount;
7. Housing: 11 x 8 x 17 inches black smooth surface metal enclosure.
8. Basis for design: Sapling Inc., Wireless Repeater.

2.5 ANALOG INDICATING CLOCKS:

A. Analog Clocks: To UL and cUL 863, designed for wireless system with fully automatic plug and play capability.
   1. Ensure secondary clock is capable of receiving wireless signals from master clock.
   2. Ensure each secondary clock works as an RF signal repeater, establishing a Mesh Network.
   3. Ensure analog secondary clock is capable of receiving Sapling wireless signals every minute for 24 V / 110V model.
   4. Clock display: 12 hour white face with black numbers.
      a. Size: Round 12 inches.
   5. Materials:
      a. Dial: Polystyrene
      b. Case: Shallow profile, smooth surface SlimLine ABS
      c. Crystal: Shatter-proof, side-molded, polycarbonate.
   6. Hand tolerance:
      a. Hour and minute hands: ±1/4 minute.
      b. Second hand: ± 1/2 minute.
   7. Power Requirements: 110 V AC, 60 Hz.

2.6 DIGITAL INDICATING CLOCKS:

A. Digital Clocks: To UL and cUL 863, designed for wireless system with fully automatic plug and play capability.
   1. Ensure secondary clock is capable of receiving wireless signals from master clock.
   2. Ensure each secondary clock works as an RF signal repeater, establishing a Mesh Network.
   3. Ensure analog secondary clock is capable of receiving Sapling wireless signals every minute for 110V model.
   4. Clock display: Six digit display.
      a. Size: 2.5” high digits.
      b. Digit Color: Furnish different display digit colors for standard time clock and elapsed timer clock in Operating Rooms.
      c. Adjustable display brightness.
   5. Materials:
      a. Case: Shallow profile, smooth surface SlimLine ABS
      b. Mount: Standard electrical two gang box.
   6. Power Requirements: 110 V AC, 60 Hz.
   7. Compliance: The clock shall be FCC compliant, in accordance with part 15 Section 15,247.
   8. Models:
      a. Time only – 3100 Series.
      b. Time and Elapsed timer – 3200 series.

2.7 ACCESSORIES

A. Wiring Kits: Provide with wiring kits for 110 VAC clocks including lead wires and quick disconnect.

B. Elapsed Timer:
1. Elapsed Timer shall be designed to be used with any Sapling 3200 or 3300 model digital clock.
2. Communications: RS485 connection and a dedicated RS485 protocol. It shall
3. Mounting: standard gang box.
4. Inputs: four and up to four swappable buttons. Each button shall include a red and green LED. LED's shall be controlled based on settings programmed in the clock.
5. The signal sent by the control panel after a single button is pressed will activate a program in the clock that causes the clock to perform a list of actions:
   a. Return to time display.
   b. Briefly display date.
   c. Go to count up and hold.
   d. Go to count up and start.
   e. Got to count down and hold.
   f. Go to count down and start.
   g. Reset.
   h. Start/Stop.
   i. Shift digits.
   j. Flash time.
6. Coordinate actions required and programming with the Owner.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that construction is complete in spaces to receive equipment and that rooms are clean, dry and permanent air conditioning systems are operating.

B. Verify that 110 volt electrical outlet is located within 6 feet of location of master clock/repeater and that outlet is operational and properly grounded.

C. Provide factory services layout system master clock and repeater equipment to ensure coverage throughout the facility.

3.2 INSTALLATION

A. Master Clock:
1. Locate master clock where indicated, a minimum of 2 to 3 feet above the floor away from large metal objects such as filing cabinets, lockers or metal framed walls.
2. Connect remote antenna to master clock, using care not to strip threads.
3. Connect power supply to the master clock.
4. Set the channel number on the display to correspond to the FCC license.

B. Repeater:
1. Locate repeater in a telecommunications closet, wall mount a minimum of 2 to 3 feet above the floor away from large metal objects such as filing cabinets, lockers or metal framed walls.

2. Connect remote antenna to repeater, using care not to strip threads.
3. Connect power supply to repeater.
4. Plug power supply into an available electrical outlet.

C. Clocks: Perform the following operations with each clock:
1. Connect to power source.
2. Set clock to correct time in accordance with manufacturer's instructions.
3. Observe clock until valid signals are received and clock adjusts itself to correct time.
4. Install the clock on the wall in the indicated location, plumb, level and tight against wall. Attach using Clock-Lock hanging method and suitable fasteners as approved by clock manufacturer.

3.3 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements, for additional requirements.

B. Inspect system to assure proper operation.

C. Manufacturer Services: Provide the services of a manufacturer authorized representative to prepare and start systems.

D. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.4 PROGRAMMING

A. Coordinate all programming, elapsed timer settings, brightness and signaling requirements with the owner.

3.5 DOCUMENTATION

A. Provide copies of all manuals and two (2) sets of as-built documents, in hard copy and electronic format. As-built documentation shall include location and types of hardware provided and installed as well as the interconnection of each device.

3.6 TRAINING:

A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.

B. Provide training to personnel selected by the Owner on operation and basic maintenance of all systems and equipment.

C. Include 4 hours of training Owner's staff.

END OF SECTION

SECTION 280529

HANGERS & SUPPORTS FOR ELECTRONIC SAFETY & SECURITY

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications

1.2 SUMMARY

A. Section Includes:
1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Equipment bases and supports.
7. J-hooks for communications cabling.

B. Related Sections:
1. Division 03 – Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Division 07 – Penetration Firestopping.
3. Section 260529 – Hangers and Supports for Electrical Systems.
4. Section 270529 – Hangers and Supports for Communications Systems.

1.3 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

B. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.

2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

1.4 SUBMITTALS

A. Division 01 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of hangers and supports.

E. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience, approved by manufacturer.

1.6 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:
1. Allied Tube & Conduit Corp.

2. Electroline Manufacturing Company.
3. O-Z Gedney Co.
4. Thomas and Betts
5. Substitutions: Division 01 - Product Requirements.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Division 01 - Product Requirements

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Division 01 - Product Requirements

B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

A. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for conduit, cable tray, raceway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

D. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. PSI Link-Seal.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6 J-HOOK SUPPORTS

A. Manufacturers:
1. Easton/Cooper B-Line – “BCH” Series
2. Caddy
3. Chatsworth
4. Substitutions: See Division 1 – Product Requirements

B. Product Description: Low-voltage and communication fasteners for routing of cabling from telecommunication room to work area outlet. J-hooks shall support all communications cabling in the project. Including, but not limited to, Category 6, 6A, fiber, speaker cabling, coaxial, security, and others.

C. Specifications:
1. Pre-galvanized steel finish
2. Static load capacity: 30 lbs
3. Quick latching cable retainer

D. Furnish with all connectors, fasteners and accessories.

E. J-Hooks shall be sized to correctly support the number of cables, which pass through them. Under no circumstances shall cable quantity exceed 50 in any given support. J-Hook shall have a maximum of 40 percent fill capacity. Install additional supports as necessary.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Obtain permission from Architect/Engineer before using powder-actuated anchors.

D. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
2. Steel Structural Elements: Provide beam clamps, spring steel clips, and welded fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

G. Backboxes for communications devices shall be permitted to be supported from a grid ceiling. A tile bridge shall be furnished for this purpose. Refer to Section 28 05 33.

H. Overhead speakers, plenum boxes, audiovisual equipment, and other devices weighing more than a standard electrical backbox shall be supported via a threaded rod fastened to the building structure.

I. J-hooks shall be furnished with cable-to-beam fasteners and shall be fastened to the building structure.

J. Separate J-hooks shall be furnished and installed for different systems. The following systems shall be routed in separate j-hook pathways:
   1. Data cabling
   2. Speaker cabling
   3. Security cabling

K. J-hook pathways shall be separated from power cabling by a minimum of 12 inches.

L. J-hook pathways shall be separated from the load side wiring of dimmer controls by a minimum of 24 inches.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Division 03.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install chrome plated steel escutcheons at finished surfaces.

3.6 FIELD QUALITY CONTROL

A. Division 01 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.7 CLEANING

A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.

3.8 PROTECTION OF FINISHED WORK

A. Division 01 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 280533

CONDUITS & BACKBOXES FOR ELECTRONIC SAFETY & SECURITY

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 260400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:
1. Section 078413– Penetration Firestopping.
2. Section 260503 - Equipment Wiring Connections.
3. Section 260533 - Raceway and Boxes for Electrical Systems.
4. Section 260553 – Identification for Electrical Systems
5. Section 262726 - Wiring Devices.
6. Section 280529 - Hangers and Supports for Electronic Safety and Security.
7. Section 280553 - Identification for Electronic Safety and Security.

1.3 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 – Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 – Specification for Electrical Metallic Tubing, Zinc Coated.

B. National Electrical Manufacturers Association:
1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 – Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
5. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.4 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and as necessary for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than 5 feet outside Foundation Wall: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.

C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.

D. In or Under Slab on Grade: Provide rigid steel conduit with rigid steel conduit sweeps. Only allowed where necessary to devices at on grade millwork.

E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.

F. Wet and Damp Locations: Provide rigid steel conduit, electrical metallic tubing. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.

G. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

H. Exposed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

I. Dry Finished Locations: Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

J. Exposed Dry Finished Locations: Provide surface metal raceway and fittings. Unless specified on drawings, requires design team approval for use of surface metal raceway in finished locations. Coordinate all vertical runs of surface raceway with the architect prior to installation.

1.5 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.6 SUBMITTALS

A. Division 01 – Submittal Procedures: Submittal procedures.

B. Product Data: Submit for the following:
1. Liquidtight flexible metal conduit.
2. Nonmetallic conduit.
3. Nonmetallic tubing.
4. Raceway fittings.
5. Conduit bodies.
6. Surface raceway.
7. Wireway.
8. Pull and junction boxes.
9. Handholes.

C. Manufacturer’s Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.7 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:
1. Record actual routing of conduits larger than 2 inch.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Division 01 – Product Requirements: Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.9 COORDINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Coordinate installation of outlet boxes for equipment connected under Section 26 0503.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

D. Division 28 contractor is responsible to fully coordinate with the site and concrete contractors and all other trades when routing conduit underslab. See Part 3 of this Section for additional backfilling requirements.

PART 2 PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Division 01 – Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; all steel fittings.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Anamet Electrical.
3. Allied Tube and Conduit.
4. Substitutions: Division 01 – Product Requirements.

B. Product Description: Interlocked steel construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Division 01 – Product Requirements.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression (damp locations), and set screw type.

2.4 SURFACE METAL RACEWAY

A. Manufacturers:
1. Hubbell Wiring Devices.
2. Thomas & Betts Corp.
3. The Wiremold Co.
4. Substitutions: Division 01 – Product Requirements.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Size: as indicated on drawings.

D. Finish: Manufacturers standard finish as selected by Architect.

E. Fittings, Boxes, and Extension Rings: Furnish manufacturer’s standard accessories; match finish on raceway.

F. Provide building wire within steel surface mounted raceway such as manufactured by Wiremold. For areas where data and power devices are located on same wall, provide divided raceway.

2.5 WIREWAY

A. Manufacturers:
1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Hoffman.
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Steel NEMA 1 wireway when inside building. Steel NEMA 3R wireway when outside building.

C. Knockouts: Manufacturer’s standard.

2.6 OUTLET BOXES

A. Manufacturers:
1. Erico Products.

2. Raco.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 – Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs.
2. Concrete Ceiling Boxes: Concrete type.

C. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

D. Wall Plates for Finished Areas: As specified in Section 26 27 26.

E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

F. Ceiling backboxes: Provide tile bridge to support mounting of backbox from ceiling grid in areas with grid ceiling. In other areas without grid ceiling, backbox shall be supported from building structure.

2.7 PULL AND JUNCTION BOXES

A. Manufacturers:
1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Division 01 – Product Requirements.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 26 27 16.

D. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
1. Material: Galvanized cast iron.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

E. Concrete Composite Handholes: Die-molded, concrete composite hand holes:
1. Minimum size: 24” x 24” unless noted otherwise on drawings.
2. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
3. Cover: Concrete composite, weatherproof cover with nonskid finish.
4. Cover Legend: “COMMUNICATIONS” (unless noted otherwise).
5. Provide handhole with divided interior when power and communications cabling are routed in same pathway.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 260526.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 280529.

C. Identify raceway and boxes in accordance with Section 280553.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION – RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 280529; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 280529.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit under slab from point-to-point.

K. Maintain clearance between raceway and piping for maintenance purposes.

L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.

R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

W. Close ends and unused openings in wireway.

X. Division 28 contractor is responsible to fully coordinate with the site and concrete contractors and all other trades when routing conduit underground or underslab. Routing of conduit underslab may be acceptable, provided spacing of conduits is adequate for proper backfilling of area surrounding conduits. Adequate spacing shall mean a minimum of 3-inches for backfilling with sand. Proposed conduit routing, installation and methods and backfilling procedures shall be submitted to the Engineer for review.

3.4 INSTALLATION – BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as specified in section for outlet device.

B. Coordinate communications device locations with furniture plan and receptacle locations to accommodate the intended purpose prior to rough-in.

C. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

D. Orient boxes to accommodate wiring devices.

E. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

F. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

G. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

H. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

J. Install stamped steel bridges to fasten flush mounting outlet box between studs.

K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

L. Install adjustable steel channel fasteners for hung ceiling outlet box.

M. Do not fasten boxes to ceiling support wires or other piping systems.

N. Support boxes independently of conduit.

O. Install gang box where more than one device is mounted together. Do not use sectional box.

P. Install gang box with plaster ring for single device outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07 Section “Penetration Firestopping”.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.

C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.6 ADJUSTING

A. Division 01 – Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.7 CLEANING

A. Division 01 – Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 280553

IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 260400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications

1.2 SUMMARY

A. Section Includes:
1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Underground Warning Tape.

B. Related Sections:
1. Division 09 – Painting and Coating: Execution requirements for painting specified by this section.
2. Section 260553 – Identification for Electrical Systems.
3. Section 270553 – Identification for Communications Systems.

1.3 SUBMITTALS

A. Division 01 – Submittal Procedures: Submittal procedures.

B. Product Data:
1. Submit manufacturer’s catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Manufacturer’s Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 – Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Division 01 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Division 01 – Product Requirements: Environmental conditions affecting products on site.

B. Install labels only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Division 01 – Product Requirements.

B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.

C. Letter Size:
1. 1/8 inch high letters for identifying individual equipment and loads.
2. 1/4 inch high letters for identifying grouped equipment and loads.

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Division 01 – Product Requirements.

B. Labels: Embossed, pre-printed adhesive tape, with 3/16 inch white letters on black background.

2.3 WIRE MARKERS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Division 01 – Product Requirements.

B. Description: Cloth tape or, split sleeve type wire markers.

2.4 CONDUIT AND RACEWAY MARKERS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Division 01 – Product Requirements.

B. Description: Nameplate fastened with straps.

C. Color:
1. Fire Alarm System: Red lettering on white background.
2. Security System (Access Control, Intrusion Detection &Video Surveillance): White lettering on black background.

D. Legend:
1. Fire Alarm System: FIRE ALARM.
2. Access Control System: ACCESS CONTROL.
3. Intrusion Detection: ALARM.
4. Video surveillance: CCTV.

2.5 LOCKOUT DEVICES

A. Lockout Hasps:
1. Manufacturers:
a. Master Lock.
b. Ideal Industries.
c. Brady.
d. Substitutions: Section 01 6000 - Product Requirements.
2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:
1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
4. Secure nameplate to equipment front using screws.

5. Install nameplates for the following:
   a. Equipment racks and cabinets.

C. Wire Label Installation:
1. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
2. Install labels at data outlets identifying patch panel and port designation as specified.

D. Conduit Marker Installation:
1. Install conduit marker for each conduit longer than 10 feet.
2. Conduit Marker Spacing: 20 feet on center.

END OF SECTION

SECTION 281523

INTERCOM SYSTEM

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Staff Voice Communication System – Internet Protocol (IP) with the following components:
1. Master stations.
2. Substations.
3. Other components.
4. Managed Switch
5. Software.

B. Related Sections:
1. Section 260553 – Identification for Electrical Systems.
2. Section 280529 – Hangers and Supports for Electronic Safety and Security.
3. Section 280533 – Conduit and Backboxes for Electronic Safety and Security.
4. Section 280553 – Identification for Electronic Safety and Security.

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. All system components, where applicable standards have been established, shall follow the recommendations of the Underwriters' Laboratories and the National Electrical Code, and must bear the UL label.

C. The system shall comply with the Americans with Disabilities Act sections 4.3.11.4 and 4.3.11.5.

D. ISO 9001 – Quality Management Systems.

1.4 SYSTEM DESCRIPTION

A. The Contractor shall furnish and install an intercom system complete including, but not limited to, outlet boxes, conduit, wiring, IP Master Station, managed switch and IP Area Stations, and all other equipment necessary to provide a complete and operating Intercom System. Equipment furnished under this section shall be the standard product of a single manufacturer.

1.5 SUBMITTALS

A. Product Data:
   1. Manufacturer's data sheets on each product to be used.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Typical installation methods.

B. Shop Drawings: Include details of materials, construction and finish. Include relationship with adjacent construction.

C. Project Record Documents: Accurately record actual locations of devices and wiring.

D. Operation Data: Include instructions for routine operation of master and remote stations.

E. Maintenance Data: Include instructions for minor troubleshooting, preventive maintenance, and cleaning.

F. Submit project-specific riser diagram with locations and quantities and locations of stations and head-end devices.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this Section with minimum three years of documented experience.

B. Supplier Qualifications: Company authorized by manufacturer and specializing in supplying products specified in this Section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in installing the products specified in this Section with minimum three years documented experience.

D. Products: Listed, classified, and labeled as suitable for the purpose intended.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 CLOSEOUT SUBMITTALS

A. Division 01 – Execution and Closeout Requirements: Requirements for submittals

B. Project Record Documents: Provide two copies of riser, layout, and wiring diagrams showing any changes to standard drawings.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.9 COORDINATION

A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.

1.10 WARRANTY

A. Contractor's Warranty: Warranty the installation to be free of defect for a period of one (1) year.

B. Manufacturer's Warranty: Warranty the equipment to be free of defect for a period of three (3) years from date of shipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Zenitel
Web: www.zenitel.com

B. Substitutions: Not permitted.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. System shall provide fast open duplex voice communication with emergency paging and active noise cancellation for high noise environments.

B. One Turbine station or Turbine station kit shall be programmed as the IC-EDGE Intercom Controller to serve as the central point for programming the system, including but not limited to programming of:
1. Station directory numbers.
2. Station text.
3. DAK keys for master stations and substations.
4. Group calls with call back.
5. Busy Override.
6. Call transfer, forward, hold.
7. Call restrictions and profiles.

C. Capable of full and open duplex, hands-free operation, without the use of handsets, at both the initiating and receiving station.

D. Built-in firewall allows opening or closing of each protocol as user wishes.

E. Auto discovery of stations supported with station IP addressing either static or DHCP.

F. IC-EDGE system shall have adaptive jitter buffering.

G. System Capacity: 64 stations, 10 soft clients, 10 SIP stations, and up to 10 SIP gateways.

H. Initial 32 stations in IC-Edge require no license per controller.

I. System expandable to interconnect 50 IC-Edge Controllers for a total of 2100 stations.

J. System shall be connected to an internal self-contained IP network.

K. Capable of adding optional features, equipment, and interfaces, even if not initially included.

L. Cyber defensibility: Integrated IEEE 802.1X network access control with regular software upgrades to ensure secure, reliable communications.

M. Turbine Audio Messaging:
1. WAV file format, PCM 16-bit, 16 kHz and single channel (mono).
2. Total message file size 20 MB, any number of file can be uploaded.
3. 15 events can be defined to trigger audio messages.

2.3 STATIONS:

A. IP OR Master: Master station for use in operating rooms that require chemical resistant and anti-bacterial front surface for easy cleaning. Station features a large high contrast display with backlight and up to 4 lines with 20 characters as well as the added feature of lighting behind each key that provides excellent readability in locations where lighting can be a problem. Station connects directly to IP network making it easy to deploy anywhere at any distance. Station has integrated web server for easy configuration, monitoring and remote automatic software updates are built in features. IP station shall use an advanced signal-processing algorithm to identify and filter out background repetitive noise signal audio. The feature shall be integrated into the IP station onboard DSP and software adjustable from the IP station integrated web server. Station provides wideband audio and may be powered locally, connected to a POE switch or power injector. Station shall be mounted in flush #1008098700 back box. Sound detection is a standard software feature included with the station. Shall be IP-CROR Cleanroom/OR Master #1008415000.

B. IP Desk Master Station: Desk master station for use in offices and control rooms. Station shall include a large high contrast display with backlight, which allows important information about connections to be shown. The station shall be equipped with 10 DAK keys for single touch access to stations, group calls, feature codes and handset for confidential conversations. It shall connect directly to IP networks and have an integrated web server for easy configuration, monitoring, and remote automatic software updates. IP station shall use an advanced signal-processing algorithm to identify and filter out background repetitive noise signal audio. The feature shall be integrated into the IP station onboard DSP and software adjustable from the IP station integrated web server. Sound detection is a standard software feature included with the station. Station shall provide wideband audio. Connection must be to a PoE switch or power injector. Shall be IPDMH(B)-V2 IP Desk Master w/handset. Coordinate color (black or white) with Owner.

C. Vandal Resistant Substation: This station is the latest generation of IP station providing a rating of IP66 along with features such as wideband audio (7kHz), active noise cancellation, automatic gain control and sound pressure levels of up to 105dB from the Class D 10-watt output amplifier. Station as well is equipped with a digital MEMS microphone that is immune to electromagnetic radiation interference and acoustically transparent poke screen that the speaker makes the speaker tamper resistant while maintaining the flow of audio. Station has PMOLED Display and 2 navigation buttons to scroll up and down in the name list along with call button and cancel button. All electronics are covered by a 3mm thick aluminum die-cast base and further reinforced by a faceplate of thermoplastic. Station supports PoE and has an integrated web server. Sound detection is a standard software feature included with the station. Station shall mount in 2 gang electrical back box #1008140020 along with TA-5 bracket #1008140050.

Turbine TCIS-6 is equipped with black thermoplastic front plate with call button. Shall be TCIS-6 #1008111060.

2.4 Accessories:

A. Managed POE Layer 3 Ethernet Switch:
1. **Layer 3 managed switch with OVCR | 24 x 1G, 16 x POE+, 245W, 2 x 10G SFP+**
2. Variable fans provide quiet cooling to protect components, and enhanced cooling will activate in warmer temperatures.
3. 19-inch rack mount.
4. Three-year warranty.

2.5 CABLING

A. All cable shall be as recommended by the manufacturer or an approved equivalent. All Area Station wiring must be home run with individually jacketed cable.

B. All cables run in underground conduits must be suitable for wet locations and appropriately grounded as per EIA and NEC recommendations. See wiring diagrams for details.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as shown on Drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions, approved submittals and in proper relationship with adjacent construction.
1. Install equipment firmly secured, plumb, and level.
2. Splices shall be in easily accessible junction boxes or on terminal boards.
3. Cable runs shall be tagged and identified at main terminal board and junction boxes.
4. Product should be configured in accordance with manufacturer-supplied hardening guide. Systems for which the manufacturer does not provide a hardened installation option are not be acceptable.

B. Provide all necessary programming for a complete system, including programming of recorded voice messages and dial out numbers.

C. System wiring shall be in accordance with good engineering practices as established by the EIA and NEC. Wiring shall meet all established state and local electrical codes. All wiring shall test free from shorts and grounded as specified.

3.3 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements, for additional requirements.

B. Provide the services of the manufacturer's technical representative to make final connections to unit; prepare and start systems; and perform field inspection and testing.

C. Perform operational test on completed installation to verify proper operation.

D. Replace equipment, components, and wiring to eliminate audible noise, clicks, pops, or hum when system is in standby or operation.

3.4 START-UP AND TESTING

A. Include all software necessary for system configuration.

B. Turn on system and make adjustments as necessary to meet indicated requirements.

C. Program system to function as specified.

D. Provide documentation of directory numbers, feature codes, and special programming.

E. Test system to assure audio server and all components, stations, speakers, and accessories are working properly.

3.5 DEMONSTRATION

A. Conduct up to four hours of instruction in use and operation of the system to designated owner representatives.

B. Program system to function as specified.

C. Provide documentation of directory numbers, feature codes, and special programming.

D. Test system to assure audio server and all components, stations, speakers, and accessories are working properly.

3.6 DOCUMENTATION

A. Provide copies of all manuals and two (2) sets of as-built documents, in hard copy and electronic format. As-built documentation shall include location and types of hardware provided and installed as well as the interconnection of each device.

3.7 CLEANING AND PROTECTION

A. Clean products in accordance with the manufacturer’s recommendations.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 283100

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fire alarm control panels, manual fire alarm stations, automatic smoke and heat detectors, fire alarm signaling appliances, and auxiliary fire alarm equipment and power and signal wire and cable.

B. Related Documents:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

C. Related Sections:
1. Section 07 8413 – Penetration Firestopping.
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
3. Section 28 05 29 – Hangers and Supports for Electronic Safety and Security.
4. Section 28 05 33 – Conduits and Backboxes for Electronic Safety and Security.
5. Section 28 05 53 – Identification for Electronic Safety and Security.

1.2 REFERENCES

A. National Fire Protection Association:
1. NFPA 72 - National Fire Alarm Code.
2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

1.3 SYSTEM DESCRIPTION

A. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

B. The fire alarm system shall comply with requirements of NFPA Standard No. 72 for Local Protected Premises Signaling Systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.
1. The Secondary Power Source of the fire alarm control panel will be capable of providing at least 24 hours of backup power with the ability to sustain 5 minutes in alarm at the end of the backup period.

C. Work under this section shall include, but not be limited to:
1. Coordination with the South Burlington Department and University Fire Marshal.
2. Providing new smoke and heat detection.
3. Providing duct mounted smoke detectors in the supply and return ducts of the new air-handling unit, including sampling tubes and coordination with Division 23.

4. Extending fan shut-down control signals from the detectors to the associated air-handling unit fans and associated dampers.
5. Providing new power supplies, power boosters, and terminal cainets as required for additional capacity of devices.
6. Providing new synchronization modules at notification appliance power supplies and circuits where synchronization capability is not built into the power supply NAC circuit.
7. Provide “SILENCE” switch with the ability to silence the notification appliance circuits from annunciator panels and at the transponder/power booster cabinet location.
8. Complete programming of the system both during construction to maintain integrity of the system and during installation to reconfigure, set-up and test the system.
9. Complete testing of the system including all required coordination and testing as directed by the Authority Having Jurisdiction.

D. Basic Performance:
1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 6 (Class A) Signaling Line Circuits (SLC).
2. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style A) as part of an addressable device connected by the SLC Circuit.
3. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z).
4. All circuits shall be power-limited, per UL864 9th edition requirements.
5. A single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm when wired to NFPA Style 6/7.
6. Alarm signals arriving at the main FACP shall not be lost following a primary power failure or outage of any kind until the alarm signal is processed and recorded.

E. Alarm Sequence of Operation: Actuation of initiating device causes the following system operations:
1. Local fire alarm signaling devices sound and display.
2. Operation of “SILENCE” switch silences audible alarms, strobe lights remain in operation.
3. Signal transmits to municipal connection.
4. Location of alarm zone indicates on fire alarm control panel and on remote annunciator panel.
5. Signal transmits to building elevator control panel, initiating return to main floor or alternate floor and lockout for fire service.
6. Signal transmits to building mechanical controls, shutting down fans and operating dampers.
7. Signal releases magnetic door hold opens.

F. Drill Sequence of Operation: Manual drill function causes alarm mode sequence of operation.

G. Trouble Sequence of Operation: System or circuit trouble causes the following system operations:
1. Visual and audible trouble alarm indicates by zone at fire alarm control panel.
2. Visual and audible trouble alarm indicates at remote annunciator panel.
3. Trouble signal transmits to Campus Monitoring Central Station.

1.4 SUBMITTALS

A. Section 01 11 05 – Summary of Work: Submittal procedures.

B. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection; indicate annunciator layout, and design calculations.
   1. Include voltage drop calculations for notification-appliance circuits.
   2. Include battery-size calculations.

C. Product Data: Submit catalog data showing electrical characteristics and connection requirements.

D. Test Reports: Indicate procedures and results for specified field testing and inspection.

E. Manufacturer's Field Reports: Indicate activities on site, adverse findings, and recommendations.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components 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. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
      b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
      c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
      d. Riser diagram.
      e. Device addresses.
      f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
      g. Record copy of site-specific software.
         1) Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
            a) Equipment tested.
            b) Frequency of testing of installed components.
            c) Frequency of inspection of installed components.
            d) Requirements and recommendations related to results of maintenance.
            e) Manufacturer's user training manuals.
      h. Manufacturer's required maintenance related to system warranty requirements.
      i. Abbreviated operating instructions for mounting at FACP and each annunciator unit.

1.6 QUALITY ASSURANCE

A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of project.

B. Installer: Certified fire alarm installer with service facilities within 100 miles of Project.

C. Design fire alarm under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Connecticut.

1.8 MAINTENANCE SERVICE

A. Section Summary of Work: Maintenance service.

B. Furnish service and maintenance of fire alarm equipment for one year from Date of Substantial Completion.

1.9 MAINTENANCE MATERIALS

A. Section Summary of Work: Spare parts and maintenance products.

B. Furnish three manual station break-glass rods.

C. Furnish six keys of each type.

D. Provide (4) manual fire alarm pullstations, complete with all labor, material, and programming, to be located in the field as directed by the Local Authority Having Jurisdiction.

E. Provide (2) addressable smoke detectors with sounder bases complete with all labor, materials and programing to be located in the field as directed by the Local Authority Having Jurisdiction.

F. Provide (4) fire alarm audio/visual appliances, complete with all labor, material, and programming, to be located in the field as directed by the Local Authority Having Jurisdiction.

1.10 EXTRA MATERIALS

A. Section Summary of Work: Spare parts and maintenance products.

B. Provide (4) manual fire alarm pullstations.

C. Provide (4) fire alarm audio/visual appliances.

D. Provide (4) addressable ceiling type smoke detectors.

E. Provide (4) addressable combination fixed temperature/rate-of-rise heat detectors.

PART 2 PRODUCTS

2.1 ACCEPTABLE EQUIPMENT AND SERVICE PROVIDERS

A. Manufacturers: The equipment and service described in this specification are those supplied and supported by Mircom, as distributed by Mammoth Fire Alarms Incorporated, and represent the base bid for the equipment.
   1. Products of equal quality and functionality as manufactured by Simplex, Edwards/EST and Notifier will be considered.

B. The equipment and service provider shall be a nationally recognized company specializing in fire alarm and detection systems. This provider shall employ factory trained and NICET Level II, Level III & Level IV certified technicians, and shall maintain a service organization within 100 miles of this project location. The equipment and service provider shall have a minimum of 10 years experience in the fire protective signaling systems industry.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
   1. Manual stations.
   2. Heat detectors.
   3. Smoke detectors.
   4. Duct smoke detectors.
   5. Automatic sprinkler system water flow.
   6. Heat detectors in elevator shaft and pit.

B. Fire-alarm signal shall initiate the following actions as required:
   1. Continuously operate alarm notification appliances.
   2. Identify alarm at fire-alarm control unit and remote annunciators.
   3. Transmit an alarm signal to the remote alarm receiving station.
   4. Release fire and smoke doors held open by magnetic door holders.
   5. Activate voice/alarm communication system.
   6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
   7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
   8. Recall elevators to primary or alternate recall floors.
   9. Activate emergency shutoffs for gas and fuel supplies.
   10. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch.
   2. Low-air-pressure switch of a dry-pipe sprinkler system.
   3. Elevator shunt-trip supervision.
   4. Zones or individual devices have been disabled.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.

3. Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at FACP.
5. Ground or single break in internal circuits of FACP.
6. Abnormal ac voltage at FACP.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of switch at FACP or annunciator.
10. Voice signal amplifier failure.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer where provided.

2.3 FIRE ALARM CONTROL PANEL (FACP)

A. Description: Field-programmable, microprocessor-based, modular, networkable, power-limited design with electronic modules.

B. Coordinate "Performance Criteria" Paragraph below with implementation details and Drawings. Addressable horns are available for notification-appliance circuits; insert a subparagraph if required. UL 864 requires compliance with software integrity requirements.

C. Performance Criteria:
1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
2. General Characteristics:
a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
b. Include real-time clock for time annotation of events on event recorder and printer.
c. Provide communication between FACP and remote circuit interface panels, annunciators, and displays.
d. FACP must be listed for connection to central-station signaling system service.
e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACP must provide minimum 5000-event history log.
f. Panels must be able to operate in a standalone degraded mode, and must be capable of node control; the ability to switch control, automatically or manually, between different nodes on system.
g. Addressable Initiation Device Circuits: FACP must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment.
h. Fire-Alarm Annunciator: Arranged for interface between human operator at FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
1) Annunciator and Display: Back-lit LCD, four lines 80 characters minimum.

2) Controls: Arranged to permit entry and execution of programming, display, and control commands.

i. Alphanumeric Display and System Controls: Arranged for interface between human operator at FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
   1) Annunciator and Display: Back-lit LCD, four lines, 80 characters, minimum.
   2) Controls: Arranged to permit entry and execution of programming, display, and control commands.

j. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
   1) Pathway Class Designations: NFPA 72, Class A.
   2) Install no more than 250 addressable devices on each signaling-line circuit.
   3) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.

k. Serial Interfaces:
   1) One dedicated RS 485 port for central-station operation using point ID DACT.
   2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).

l. Smoke-Alarm Verification:
   1) Initiate audible and visible indication of "alarm-verification" signal at FACP.
   2) Activate approved "alarm-verification" sequence at FACP and detector.
   3) Record events by system printer.
   4) Sound general alarm if alarm is verified.
   5) Cancel FACP indication and system reset if alarm is not verified.

m. Notification-Appliance Circuit:
   1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
   2) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.

n. Elevator Recall: Initiate by one of the following alarm-initiating devices:
   1) Elevator lobby detectors except lobby detector on designated floor.
   2) Smoke detectors in elevator machine room.
   3) Smoke detectors in elevator hoistway.

o. Elevator controller must be programmed to move cars to alternate recall floor if lobby detectors located on designated recall floors are activated.

p. Water-flow alarm connected to sprinkler in elevator shaft and elevator machine room must shut down elevators associated with location without time delay.
   1) Water-flow switch associated with sprinkler in elevator pit may have delay to allow elevators to move to designated floor.

q. Remote Smoke-Detector Sensitivity Adjustment: Controls must select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

r. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.
s. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators.
t. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of central-control microphone. Amplifiers must comply with UL 1711.
    1) Allow application of, and evacuation signal to, indicated number of zones and simultaneously allow voice paging to other zones selectively or in combination.
    2) Programmable tone and message sequence selection.
    3) Standard digitally recorded messages for "Evacuation" and "All Clear."
    4) Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of FACP.
u. Status Annunciator: Indicate status of various voice/alarm speaker zones and status of firefighters' two-way telephone communication zones.
v. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
w. Primary Power: 24 V DC obtained from 120 VAC service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory and DACT must be powered by 24 V(dc) source.
x. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.
y. Secondary Power: 24 VDC supply system with batteries, automatic battery charger, and automatic transfer switch.
z. Batteries: Sealed, lead acid.

D. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

2.4 ADDRESSABLE MANUAL PULL STATIONS

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
    1. Double-action mechanism requiring two actions to initiate alarm, breaking-glass or plastic-rod type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP.
    2. Station Reset: Key- or wrench-operated switch.
    3. Able to perform at up to 90 percent relative humidity at 90 deg F.
    4. Material: Manual stations made of die-cast metal.
    5. Backbox: Manufacturer's standard.

2.5 ADDRESSABLE ANALOG SMOKE SENSORS

A. General Requirements:
   1. Regulatory Requirements:
      a. NFPA 72.
      b. UL 268.
   2. General Characteristics:
      a. Detectors must be two-wire type.
      b. Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
      c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
      d. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
      e. Rotary switches for detector address setting. Binary jumpers or DIP switches are unacceptable.
      f. Detector address must be accessible from FACP and must be able to identify detector's location within system and its present obscuration value.
      g. Operator at FACP, having designated access level, must be able to manually access the following for each detector:
         1) Primary status.
         2) Device type.
         3) Present analog value.
         4) Sensor range (analog value).
         5) Percent to alarm.
         6) Obscuration percentage.
      h. Detector must have functional humidity range within 90 percent relative humidity.
      i. Retain "Color" Subparagraph below if a specific color is required.
      j. Color: White.
      k. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be capable of 15°F/min. rate of rise detection.
      l. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at 135 deg F.
      m. Number of settable levels in FACP varies among manufacturers and between detector types. Indicate specific number of levels on Drawings or in "Remarks" column of a detector schedule.
      n. Continuous, automatic sensitivity adjustment using drift compensation and smoothing algorithms. Generates trouble alarm if incapable of compensating for existing conditions.
      o. Multiple levels of detection sensitivity for each sensor.
      p. Sensitivity levels based on time of day.
      q. Capable of functional test via application of magnetic field to verify alarm receipt at FACP.

2.6 ADDRESSABLE DUCT SMOKE SENSOR

A. Standard Addressable Duct Smoke Sensor Unit. Photoelectric type, with sampling tube extending the full width of the duct. Duct housing shall include relay or relay driver as required for fan shutdown.

B. Performance Criteria:
1. Regulatory Requirements:
a. NFPA 72.
b. UL 268A.
2. General Characteristics:
a. Detectors must be two-wire type.
b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
d. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
e. Rotary switches for detector address setting. Binary jumpers or DIP switches are unacceptable.
f. Detector address must be accessible from FACP and must be able to identify detector's location within system and its present obscuration value.
g. Operator at FACP, having designated access level, must be able to manually access the following for each detector:
1) Primary status.
2) Device type.
3) Present analog value.
4) Sensor range (analog value).
5) Percent to alarm.
6) Obscuration percentage.
h. Continuous, automatic sensitivity adjustment using drift compensation and smoothing algorithms. Generates trouble alarm if incapable of compensating for existing conditions.
i. Each sensor must have multiple levels of detection sensitivity.
j. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
k. Each duct smoke sensor shall be provided with a Remote Test Station with an alarm LED and test switch.

2.7 ADDRESSABLE HEAT SENSORS

A. Performance Criteria:
1. Regulatory Requirements:
a. NFPA 72.
b. UL 521.
2. General Characteristics:
a. Temperature sensors must test for and communicate sensitivity range of device.
3. Actuated by fixed temperature of 135 deg F or rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
4. Mounting: Twist-lock base interchangeable with smoke-detector bases.
5. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
6. Rotary switches for detector address setting. Binary jumpers or DIP switches are unacceptable.
7. Detector must have functional humidity range of 90 percent relative humidity.
8. Color: White.

B. Unless otherwise indicated, sensors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for temperature by fire-alarm control unit.

2.8 ADDRESSABLE CO SENSOR

A. Description: Carbon monoxide detector listed for connection to fire-alarm system.

B. Performance Criteria:
   1. Regulatory Requirements:
      a. NFPA 72
      b. NFPA 720.
      c. UL 2075.
   2. General Characteristics:
      a. Mounting: Adapter plate for outlet box mounting.
      b. Testable by introducing test carbon monoxide into sensing cell.
      c. Detector must provide alarm contacts and trouble contacts.
      d. 10-year CO cell with end-of-life warning.
      e. Detector must send trouble to FACP when nearing end-of-life, power supply problems, or internal faults.
      f. Locate, mount, and wire in accordance with manufacturer's written instructions.
      g. Rotary switches for detector address setting. Binary jumpers or DIP switches are unacceptable.
      h. Automatic drift compensation of CO cell.
      i. Test button simulates alarm condition.

2.9 NOTIFICATION APPLIANCES

A. Standard Speaker: Speaker notification appliances shall be listed to UL 1480.
   1. The speaker shall operate on a standard 25VRMS or 70.7VRMS.
   2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 86 dBA at 10 feet.
   3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm signaling.
   4. The speaker shall install directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.

B. Speaker/Strobe: Combination Speaker/Strobe units combine the speaker and visible functions into a common housing. The speaker/strobe shall be listed to UL 1971 and UL 1480.
   1. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.
   2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 86 dBA at 10 feet.
   3. The speaker/strobe shall have a frequency response of 400 to 4000 Hz for Fire Alarm signaling.
   4. The speaker/strobe installs directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.
   5. Multi-Candela Strobe Rated Light Output:
      a. Standard Output Strobe: 15, 15/75, 30, 75, 110 or 125 cd, selectable in field.

b. High Output Strobe: 15/75, 50, 75, 90, 130 or 185 cd, selectable in field.

C. Horns: Product Description: NFPA 72, flush type fire alarm horn with the following features:
1. Sound Rating: 87 dB at 10 feet.
2. Integral strobe lamp and flasher with white lettered "FIRE" on red housing where indicated.

D. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, NFPA 2002 and shall meet the following criteria:
1. The pulse duration shall be between minimum of one second and maximum of two seconds.
2. Strobe intensity shall meet the requirements of UL 1971, NFPA 2002 and ADA.
3. Multi-Candela Strobe Rated Light Output:
a. Standard Output Strobe: 15, 15/75, 30, 75, 110 or 125 cd, selectable in field.
b. High Output Strobe: 15/75, 50, 75, 90, 130 or 185 cd, selectable in field.
4. All visual units shall be synchronized to meet ADA requirements using sync modules.

E. NAC POWER EXTENDER
1. The SLC NAC Power Extender panel shall be a stand-alone panel capable of powering a minimum of 4 notification appliance circuits. Notification appliance circuits shall be Class A, Style Z rated at 2 amps each. Panel shall provide capability to be expanded to 8 notification appliance circuits.
2. The internal power supply and battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.
3. The NAC extender panel may be mounted close to the host control unit or can be remotely located. The SLC Addressable NAC Extender Panel when connected to an addressable panel shall connect to the host panel via an SLC communications channel.
4. Alarms from the host fire alarm control unit shall signal the NAC power extender panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the host panel.

2.10 ADDRESSABLE DRY CONTACT MONITOR MODULE

A. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any normally open dry contact device) to one of the fire alarm control panel SLCs.

B. The monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box.

C. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

2.11 ADDRESSABLE CONTROL RELAY MODULE

A. Addressable control relay modules shall be provided to control the operation of fan shutdown and other auxiliary control functions.

B. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.

C. The control relay module shall have a minimum of two normally open and two normally closed contacts available for field wiring.

D. The control relay module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

2.12 BATTERIES:

A. The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure. Provide battery calculations with the submittals to verify requirements are met.

B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

C. If necessary to meet standby requirements, external battery cabinet and charger systems may be used.

2.13 REMOTE LCD ANNUNCIATOR

A. Provide a remote LCD Annunciator, with the same "look and feel" as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys; Status LEDs and LCD Display as the FACP.

B. General Characteristics:
1. Annunciator functions must match those of FACP for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACP, including acknowledging, silencing, resetting, and testing.
   a. Consoles suitable for desk or semiflush wall mounting or for setting into an architectural wall, cabinet, or table as directed by the Architect.
   b. Lockable Enclosures: Fire Department approved key.
2. Display Type and Functional Performance: Alphanumeric display and LED indicating lights must match those of FACP. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.14 DIGITAL ALARM COMMUNICATOR TRANSMITTERS (DACTs)

A. Performance Criteria:
1. Regulatory Requirements:
   a. NFPA 72.

B. GENERAL CHARACTERISTICS:
1. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
2. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACP and automatically capture two telephone lines and dial preset number for remote central station. When contact is made with central station(s), signals must be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter must initiate local trouble signal and transmit signal indicating loss of telephone line to remote alarm receiving station over remaining line. Transmitter must automatically report telephone service restoration to

central station. If service is lost on both telephone lines, transmitter must initiate local trouble signal.

3. Local functions and display at DACT must include the following:
   a. Verification that both telephone lines are available.
   b. Programming device.
   c. LED display.
   d. Manual test report function and manual transmission clear indication.
   e. Communications failure with central station or FACP.
4. Digital data transmission must include the following:
   a. Address of alarm-initiating device.
   b. Address of supervisory signal.
   c. Address of trouble-initiating device.
   d. Loss of ac supply.
   e. Loss of power.
   f. Low battery.
   g. Abnormal test signal.
      1) Communication bus failure.
5. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.15 CONDUIT AND WIRE

A. Conduit:
1. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
2. Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch minimum.
7. All fire alarm junction boxes shall be painted red for identification.

B. Wire:
1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and signaling line circuits, and 14 AWG for notification appliance circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
5. Wiring used for the SLC multiplex communication loop shall be twisted and shielded and support a minimum wiring distance of 10,000 feet. The system shall

permit use of IDC and NAC wiring in the same conduit with the SLC communication loop.

6. All field wiring shall be completely supervised.

C. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

E. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

2.16 Record Document Cabinet

A. Provide Space Age Electronics, Inc. FAD series, model SSU00685 red storage cabinet with the following features:
1. 16 gauge steel construction with lock and key.
2. Solid stainless steel piano hinge for lockable door.
3. Dimensions: 12” w x 13” h x 2 ¼” d.
4. Permanently screened label with “Fire Alarm Documents” on cover.
5. Legend sheet, business card holder and key rings inside.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 11 05 – Summary of Work: Coordination and project conditions.

B. Verify products and systems receiving devices are ready for installation.

3.2 INSTALLATION

A. Install manual station with operating handle 48 inches above floor.

B. Install audible and visual signal devices 7 feet 6 inches above floor.

C. All fire detection and alarm system devices, control panels, battery cabinets and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. All strobe lights shall be synchronized in accordance with NFPA 72 and ADA Guidelines.

E. Mount outlet box for electric door holder to withstand 80 pounds pulling force.

F. Connect conduit and wire to door release devices, sprinkler flow switches, sprinkler valve tamper switches, duct smoke detectors, HVAC Starters/controllers for fan shut-down, and other system control devices as indicated on the drawings.

G. Automatic Detector Installation: Conform to NFPA 72.

H. Install engraved plastic nameplates in accordance with Section 26 05 53.

I. Ground and bond fire alarm equipment and circuits in accordance with Section 26 05 26.

J. Notification Appliance Zoning: Refer to Appendix A for Building Smoke Compartments for zoning of notification appliance circuits.

3.3 FIELD QUALITY CONTROL

A. Section 01 11 05 – Summary of Work: Field inspecting, testing, adjusting, and balancing.

B. Test in accordance with NFPA 72 and local authority requirements.

3.4 MANUFACTURER'S FIELD SERVICES

A. Include services of factory certified technician to supervise installation, adjustments, final connections, and system testing.

3.5 TEST

A. The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72 and the following:
   1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
   2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
   3. Verify activation of all waterflow switches.
   4. Open initiating device circuits and verify that the trouble signal actuates.
   5. Open and short signaling line circuits and verify that the trouble signal actuates.
   6. Open and short notification appliance circuits and verify that trouble signal actuates.
   7. Ground all circuits and verify response of trouble signals.
   8. Check presence and audibility of tone at all alarm notification devices.
   9. Check installation, supervision, and operation of all intelligent detectors using the walk test.
   10. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
   11. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.6 INSTRUCTION

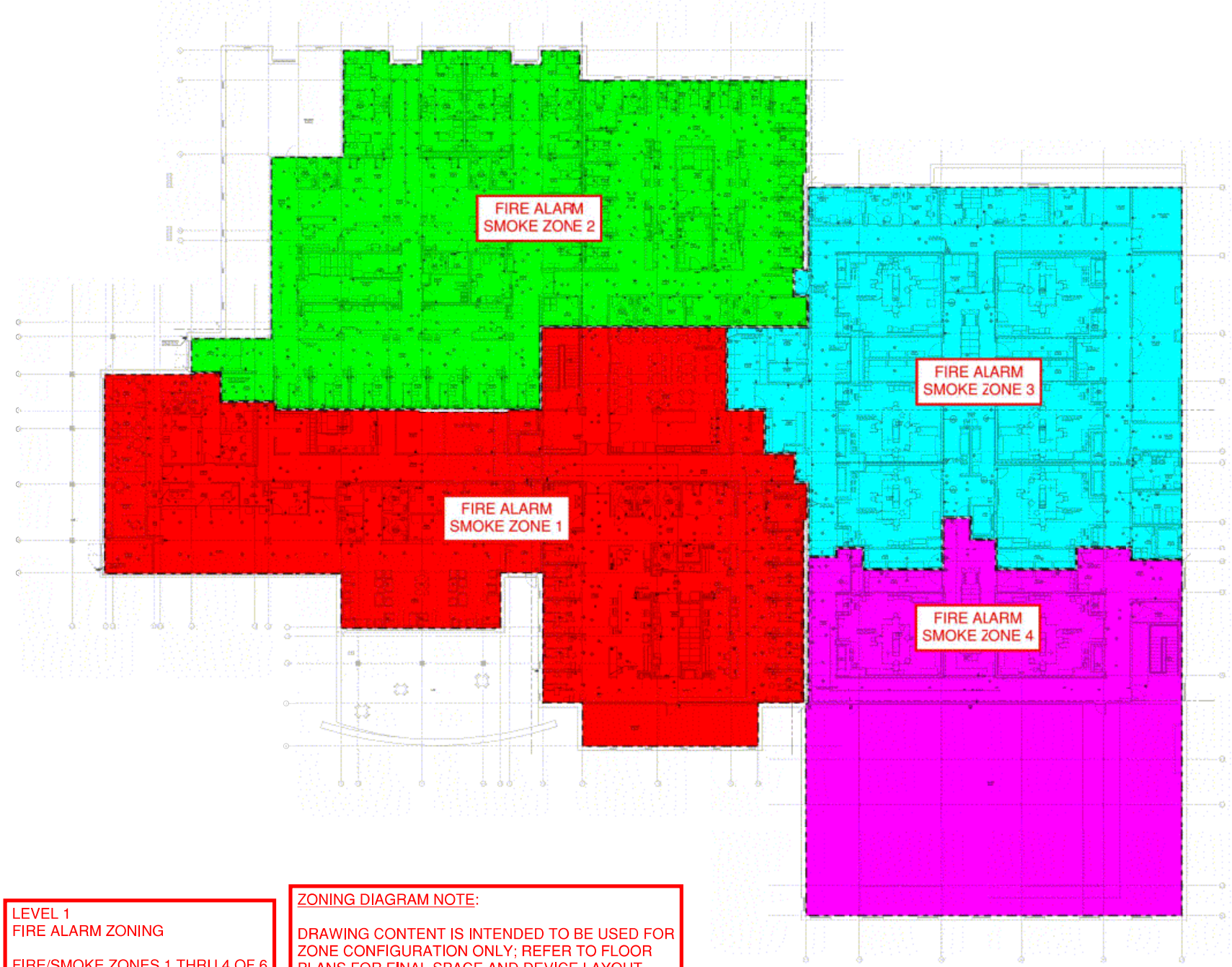
A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation" to the Owner.

C. Manufacturer’s representative shall provide Owner with a minimum of four (4) hours of onsite training on system. This training shall be followed up with an additional four (4) hours of onsite instruction at the discretion of the Owner, at any time during the warranty period.

END OF SECTION

Appendix A
Fire Alarm Smoke Zones

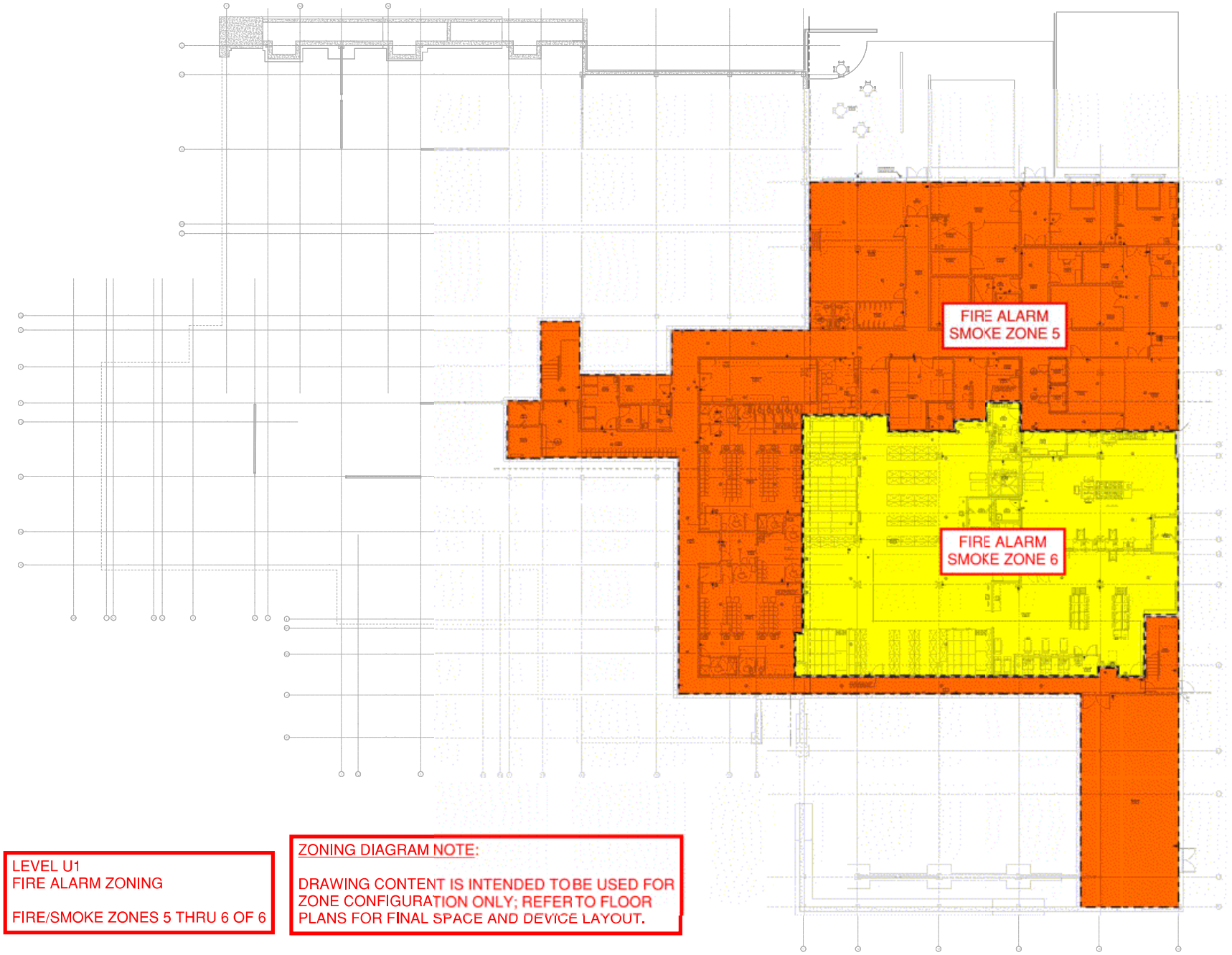


LEVEL 1
FIRE ALARM ZONING

FIRE/SMOKE ZONES 1 THRU 4 OF 6

ZONING DIAGRAM NOTE:

DRAWING CONTENT IS INTENDED TO BE USED FOR ZONE CONFIGURATION ONLY; REFER TO FLOOR PLANS FOR FINAL SPACE AND DEVICE LAYOUT.



LEVEL U1
FIRE ALARM ZONING

FIRE/SMOKE ZONES 5 THRU 6 OF 6

ZONING DIAGRAM NOTE:

DRAWING CONTENT IS INTENDED TO BE USED FOR ZONE CONFIGURATION ONLY; REFER TO FLOOR PLANS FOR FINAL SPACE AND DEVICE LAYOUT.

SECTION 311100

CLEARING, GRUBBING & STRIPPING

PART 1 - GENERAL

1.0 DESCRIPTION:

A. Work included: Clearing, grubbing and stripping shall be performed where required to assure necessary quality of the work and conservation of topsoil.

1.1 JOB CONDITIONS:

A. Requirements of Regulatory Agencies: State and local codes shall control the disposal of organic material. No cutting and disturbing of trees or shrubs in a public way shall be performed until such time as the Contractor has obtained a permit from the local governing authority.

B. Protection: Protect the area beyond the limit of clearing from damage by erecting barricades, fencing, wrapping or other protective methods.

PART 2 - PRODUCTS

2.0 EQUIPMENT: Equipment shall be at the Contractor's option and acceptable to the Engineer.

PART 3 - EXECUTION

3.0 CLEARING:

A. Clearing shall consist of felling, trimming and cutting into sections and the satisfactory disposal of such trees and limbs as well as the cutting and satisfactory disposal of bushes, brush and other vegetation. This work shall include the removal and disposal of down timber, rubbish and debris found existing within the areas to be cleared. All materials as stated above shall become the property of the Contractor.

B. Clearing as required to accommodate the construction shall be performed. When clearing is performed in advance of trench excavation, is shall be performed within the construction easement agreements previously negotiated by the Owner.

3.1 GRUBBING:

A. Grubbing shall consist of removal and disposal of stumps, roots larger than 2 inches in diameter and matted roots from areas to be grubbed. This material, together with other organic matter and other debris which is not suitable for subgrade or foundation purposes shall be excavated to a depth of not less than 18 inches below original ground surface.

B. The limits of grubbing coincide with the limits of clearing. All stumps and trees shall be removed by the Contractor to a State approved landfill.

3.2 STRIPPING:

A. Strip topsoil from all areas which will be substantially disturbed by or during construction. Avoid mixing topsoil with subsoil and stockpile it in areas on the site as approved by the Engineer. Topsoil shall be stockpiled free from brush, trash, stones and other extraneous material and protected until it is placed. Remaining topsoil shall remain property of Owner and be moved to a location as determined by the Owner.

3.3 DISPOSAL:

A. All organic material, rubbish and debris of whatever nature shall be removed from the site daily. Ultimate disposal shall be provided as part of the work.

PART 4 - REFERENCE

A. All work related to the preceding specifications, unless otherwise noted, shall be accomplished in accordance with the State of Vermont Agency of Transportation "Standard Specifications for Construction", dated 2018.

END OF SECTION

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SECTION 312300

SITE EARTHWORK

(For areas beyond five feet outside the building)

PART 1 - GENERAL

1.0 DESCRIPTION:

A. The work of this section consists of preparation, excavating, filling, trenching, backfilling and surface restoration associated with the construction of pipelines and all appurtenant structures.

B. Information on the drawings relating to existing utility lines and services is from the best sources presently available. All such information is furnished only for the convenience of the Contractor and is not guaranteed. Excavate test pits as required to determine exact locations of existing utilities.

C. Strip topsoil from all areas which will be substantially disturbed by or during construction. Avoid mixing topsoil with subsoil and stockpile it in areas on the site as approved by the Engineer. Topsoil shall be stockpiled free from brush, trash, stones and other extraneous material and protected until it is placed. Remaining topsoil shall remain property of Owner and be moved to a location as determine by Owner.

D. All organic material, rubbish and debris of whatever nature shall be removed from the site. Ultimate disposal shall be provided as part of the work.

E. All material, equipment, supplies and accessories required are to be provided. All excavation will be open cut. Work items include but are not limited to removal of pavement and structures, protection of trees and structures to remain, stripping and stockpiling topsoil, excavation, controlled stockpiling of excavated materials, trench protection, cribbing and cofferdams, dewatering, backfill materials and construction, bedding preparation, scarification, finish grading, and incidental work.

F. It also includes surface restoration including pavement replacement, curb replacement, path replacement, machine and hand grading and shaping, dressing with topsoil, and disposal of excess materials.

G. When excavation is complete, verify depths and dimensions

H. Excavate sub-soil in accordance with lines and levels required for construction of the work, including space for forms, bracing and shoring, foundation drainage system, applying damp proofing, waterproofing, utility systems, and to permit inspection. Do additional excavation only by written authorization of Engineer.

I. Machine-slope banks

J. Hand-trim excavations and leave free from loose or organic matter.

K. Correct unauthorized excavation as directed, at no cost to Owner.

Excavations are not to interfere with normal 45-degree bearing splay of any foundation, except as required for new utility connections.

L. Stockpile excavated subsoil for re-use where directed. Remaining excess soil shall be removed from property.

M. Do not disturb soil within branch or root spread of existing trees or shrubs that are to remain.

N. Accurately locate and record abandoned and active utility lines rerouted, extended, or found on Project Record Documents. Provide digital copy to Owner on AutoCAD based drawing format.

1.1 JOB CONDITIONS:

A. If unauthorized over-excavation occurs, the Contractor shall at no cost to the Owner, be responsible for the repair of the area by backfilling with approved bedding material and compacting to 95 percent maximum density (AASHTO-T-99 Standard Proctor) for pipelines.

B. Bidders are expected to examine the project to determine the character of materials to be encountered, trees to be removed or protected, and nature of the work in general.

1.2 DEFINITIONS:

A. Excavation Classification: The definition of excavation shall include materials of every description, and of whatever substances encountered, to the depths and or the areas required for the construction work. No classification will be made of the materials excavated either as to depth, nature, composition, hardness, nor degree of water content.

B. Bedding: Material placed in the excavation below the bottom of pipe or structure.

C. Haunching, Initial Backfill: Material placed in trench excavation after pipe is in place above bedding to 2 inches above the pipe and below final backfill.

D. Final Backfill: Material placed in excavation above pipe haunching.

E. Compaction Density: Reference to densities will be as determined by AASHTO-T-99 Standard Proctor at moisture content within 2 percent of optimum. (Except under buildings.

F. Natural Area: Areas on project limits which are grassed or landscaped.

PART 2 - MATERIALS

2.0 GENERAL:

A. All backfill material shall be approved before use. Approved material from project excavations shall be used for backfill. The backfill material shall be free from rubbish, large stones, clods, roots, brush, debris, frozen lumps of earth, or other objectionable material, and shall be moistened if required.

B. The amount of water used in compaction shall be optimum to obtain the percent relative compaction required. The amount of water required shall be controlled by the Contractor to meet conditions brought about by storms, drought, or other causes.

2.1 EXCAVATED MATERIALS:

A. Use only approved excavated material for backfill. Excess excavated material for backfill shall be stockpiled and transported and used in areas of deficiency.

2.2 FINAL BACKFILL FOR WATER AND SEWER LINES:

A. Material for final backfill shall meet requirements defined on the trench detail(s) on the plans.

2.3 BEDDING, HAUNCHING AND INITIAL BACKFILL MATERIAL:

A. Material shall be predominantly sand, gravel, crushed stone or sandy soil as defined on the trench detail(s) on the plans.

2.4 WATER:

A. Clean, free from harmful substances.

PART 3 - EXECUTION

3.0 PREPARATION:

A. Topsoil: In natural areas, strip all topsoil, or in the absence of topsoil, strip the top surface material and store separately from other excavated materials in stockpile areas designated by the Engineer's Representative.

B. Ground Surface Preparation: Prior to excavating, complete all clearing and grubbing operations.

C. The Contractor is to field verify by excavation the location of all utility crossings, service connections, connections to existing lines at least 300 feet (91.4M) in advance of the pipe laying and trench excavation before proceeding. Failure to comply with this specification shall result in the Contractor waiving any claim to compensation resulting from conflicts with the existing utilities.

D. Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.

E. Erosion prevention and sediment control measures shall be installed and maintained in accordance with the approved plans. Soil exposure shall be limited to the shortest duration possible and no longer than applicable permits allow. To the greatest extent practicable, the Contractor shall implement all Best Management Practices necessary to minimize the potential for eroded sediment from leaving the site.

3.1 TRENCH EXCAVATION:

A. General: Excavate trenches to lines, grades, and elevations indicated. Fine grade the trench bottom throughout and excavate to accommodate joints and connections so the barrel of the pipe will receive bearing pressure throughout its entire length.

B. Notify Engineer of unexpected sub-surface conditions and discontinue work in area until Engineer's Representative provides notification to resume work.

C. Protect bottom of excavations and soil around and beneath foundations from frost.

D. Trenching Guidelines: For excavation, trench width and depth shall be as follows: width ample to allow a minimum free working space of 1 foot (30.5 CM) on each side of pipe barrel, depth as indicated. Trench shall have vertical side walls from 12 inches (30.5 CM) above pipe to the bottom. Upper trench walls may be sloped back for safety and access. Trenches excavated to over width or over depth is the Contractor's responsibility to repair at no extra cost to the Owner.

E. Types of Excavation: Contractor to perform excavation with capable equipment. Hand excavation is required around tree roots inside the tree drip line, thrust blocks, and adjacent to existing utilities and structures.

F. Barricade open excavations occurring as part of this work and post warning lights in accordance with all OSHA requirements.

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.

3.2 SHORING AND SHEETING:

A. Construct and maintain all shoring and sheeting necessary to protect the excavation, as needed for the safety of the employees and as required by applicable State and Federal laws.

B. Do not disturb or remove timber or other sheeting driven to a depth below the elevation of the top of the pipe or structure footing.

C. As directed, remove all other sheeting and shoring when safe to do so. Any portion wholly buried by earth and at a distance of at least 18 inches (45.7 CM) from any timber members of permanent structures need not be stripped.

3.3 DEWATERING:

A. For all excavation, the Contractor shall provide suitable equipment to remove water, and shall keep the excavation dewatered so that pipe laying, forming, and a concrete work can be carried on under dewatered conditions. As part of this Contract, and in coordination with dewatering requirements of other excavation work on the project, the Contractor shall be responsible for handling and disposal of any excess water in a suitable manner so as to prevent violations of Water Quality Standards and to prevent damage to surrounding property. Natural drainage ways near the site may be used to the extent of their natural capacity if no erosion or other damage is encountered. No water shall be drained to existing utility systems without permission from Engineer.

3.4 STORAGE OF EXCAVATED MATERIALS

A. Generally excavated material will be placed so that no amount will be lost or spoil terrain on the side slopes below the work area.

B. In natural areas, place excavated material close to the excavation and in as confined a configuration as possible.

3.5 TRENCH BACKFILL/FILL AREAS

A. Backfill trenches immediately after approval of the pipeline construction.

B. Bedding: See plans for trench detail(s).

C. Sanitary Sewer and Underdrain Trench Backfill: See trench detail(s) on plans. Puddling or flooding of trench for consolidation of backfill or use of wheel rolling by construction equipment will not be permitted.

D. Natural Areas: As directed by the Engineer, mound slightly as approved by the Engineer at the surface to allow settlement to adjacent grades. Grade diversion bars as directed

E. All fill areas will be constructed in accordance with road embankment fill specifications.

3.6 UNSUITABLE MATERIALS:

A. At locations where unstable or undesirable conditions are encountered and as designated by the Owner, the Contractor will excavate and dispose of excavated materials. This material will be replaced by suitable materials from other project earthwork which will be placed and compacted according to the requirements of the item of work involved.

3.7 RESTORATION:

A. In natural areas clear the subgrade of materials larger than 2 inches except in natural areas where directed. Excavate to a depth of 12 inches all areas that have become saturated with oil, gasoline, or bituminous products; backfill with approved material.

B. After rough grading subgrade, loosen and till by discing, harrowing, raking, or other approved methods. Where available, place previously stripped topsoil on disturbed earth areas. Hand rake in areas inaccessible to construction equipment. Grade to produce a well-drained finish.

C. Finish all slopes in accordance with the lines cross-sections, and slope rounding shown. The final slope surface shall be similar to that surface obtained by using a farm disc or harrow parallel to the contours and shall merge with the adjacent terrain without noticeable breaks, humps or undulations. Seed, fertilize and mulch as required by the specifications and plans.

D. Place dead trees, large rocks and cobbles to match the natural setting where directed or dispose of as directed by the Engineer. Leaving excess materials in unnatural mounds along the route of the trenches is not acceptable.

E. Any material that has become saturated with oil, gasoline, etc. needs to be reported to the Owner.

3.8 CLEANUP:

A. Prior to final inspection and acceptance, remove all rubbish and excess materials and leave area in a neat, satisfactory condition.

3.9 SHRINKAGE AND MAINTENANCE:

A. Contractor shall be responsible for the stability of all embankments until final acceptance, and for replacing any portions which have become displaced or damaged due to carelessness or negligence or due to damage resulting from natural causes. The Contractor shall also be responsible for preventing trench settlement, and for making any repairs due to trench settlement.

3.10 SITE COMPACTION TESTING:

A. Testing of compacted fill materials will be performed by a testing laboratory appointed and paid for by the Owner. Any retesting costs will be the responsibility of the Contractor.

B. When work of this Section or portions of work are completed, notify the testing laboratory to perform tests. Do not proceed with additional portions of work until results have been verified.

C. If, during progress of work, tests indicate that compacted materials do not meet specified requirements, remove defective work, replace and retest at no cost to Owner.

D. Ensure compacted materials are tested before proceeding with placement of additional material.

E. See Section 02201 for additional soil testing specifications.

3.11 DRAINAGE AND FROST PROTECTION:

A. Contractor shall control grading in all construction areas so that the surface of the ground will properly slope to prevent accumulation of water in excavated areas.

B. Should surface, rain, or ground water be encountered during operations, Contractor shall furnish and operate pumps or other equipment and provide all necessary piping to keep all excavations clear of water at all times and shall be responsible for any damage to work from such water.

C. Presence of ground water in soil will not constitute a condition for which an increase in the contract price may be made. Under no circumstances place concrete fill, lay piping, or install appurtenances in excavation containing free water.

D. Contractor shall not excavate to full indicated depth when freezing temperatures may be expected, unless work can be completed to subgrade or piping can be installed and backfilled the same day. Protect, excavation from frost if placing of concrete or piping is delayed.

E. Contractor shall keep operations clear and free of accumulation of snow within limits of contract lines as required to carry out the work. No work shall be installed on frozen ground. Protect excavation bottoms against freezing when atmospheric temperature is less than 30°F (1.1°C).

PART 4 - REFERENCE

A. All work related to the preceding specifications, unless otherwise noted, shall be accomplished in accordance with the State of Vermont Agency of Transportation “Standard Specifications for Construction”, dated 2018.

END OF SECTION

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SECTION 320500

GRAVEL AND AGGREGATE BASE COURSES

PART 1 - GENERAL

1.0 GENERAL PROVISIONS: Coordinate Work with that of other trades affecting or affected by Work of this Section. Cooperate with such trades to assure the steady progress of the Work.

1.1 DESCRIPTION OF WORK: Provide labor, materials, equipment and services necessary for proper and complete installation of the gravel subbase and base courses for pavement, walks, and concrete slab areas, as indicated on the Drawings and herein specified:

A. Preparation of subgrade.

B. Gravel subbase course.

C. Gravel base course.

D. Materials compaction and compaction testing as required.

1.2 QUALITY ASSURANCE:

A. Codes and Standards: The Work under this Section shall conform to the following, except as may be modified herein:

1. American Society for Testing and Materials (ASTM), Standard Specifications and Methods of Testing.
    a. D422 Method for Particle Size Analysis of Soils
    b. D698 Test for Moisture-Density Relations of Soils Using 5.5 lb. (2.5 kg) Rammer and 12 inch (304.8mm) Drop (Standard Proctor)
    c. D1557 Test for Moisture-Density Relations of Soils using 10-lb (4.5 kg) Rammer and 18-inch (457 mm) Drop (Modified Proctor)
    d. D2922 Tests for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
    e. D3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
2. American Association of State Highway and Transportation Officials (AASHTO), Latest Edition: T 88 Mechanical Analysis of Soils.

1.3 SUBMITTALS:

A. Furnish samples, test reports, and materials certifications prepared by soils testing laboratory as required for gravel base and sub-base. Certifying, by the Contractor, that the materials comply with, or exceed the requirements herein.

B. Test Results:
1. Mechanical analysis (ASTM D422) and moisture-density curve (ASTM D1557M) test results for gravel subbase and base courses.
2. Field Density test results (ASTM D2922).

1.4 RELATED SECTIONS: Section 31 23 00 Site Earthwork.

PART 2 MATERIALS

2.0 GEOTEXTILE FABRIC FOR SUBGRADE:

A. Heavy-duty, woven polypropylene stabilization fabric, Mirafi 500X or equivalent.

2.1 GRAVEL SUBBASE:

A. Clean gravel of hard durable particles free from vegetable matter, organics, lumps or balls of clay and other deleterious substances. The gradation of the part that passes a 3-inch sieve shall meet the grading requirements of Vermont AOT Specifications as presented below:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieve
4”	95-100
No. 4	25-50
No. 100	0-12
No. 200	0-6.0

Aggregate for subbase shall not contain particles of rock which will not pass the 4-inch square mesh sieve.

2.2 Aggregate Surface/Leveling Course

A. Screened and washed bank run round gravel of hard durable particles free from vegetable matter, organics, lumps or balls of clay and other deleterious substances. The gradation of the part that passes a 2-inch sieve shall meet the grading requirement of Vermont AOT Specifications as presented below:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieve
2”	100
1-1/2 in.	90-100
No. 4	30-60
No. 100	0-12
No. 200	0-6.0

Aggregate for base shall not contain particles of rock which will not pass the 2-inch square mesh sieve and shall match the look and color of the existing driveway surface aggregate.

PART 3 - EXECUTION

3.0 SUBGRADE PREPARATION FOR GRAVEL BASE COURSES

A. Prior to subgrade preparation the construction stakeout shall be performed by the Contractor.

B. Use a power grader or other approved equipment to form and shape the subgrade to conform to the specified subgrade elevations and cross-section. Remove stones greater than 4” from the subgrade and fill depressions with suitable material.

C. Roll subgrade with a minimum four passes to provide a smooth free draining subgrade surface. Roller: ten-ton minimum weight in all open areas; suitable equipment in confined spaces. Compact subgrade to 95% of maximum laboratory density (ASTM-D 2922; Nuclear Method Density). Shape to smooth surface free of irregularities. Protect from damage by proper construction of drainage swales as shown and directed, prior to placement of gravel subbase.

D. Areas of soft, yielding or other unsuitable material that will not compact shall be removed and replaced with a suitable material and property compacted as directed by the Engineer or Owner’s Representative.

E. After a proof roll is completed in the presence of the Engineer or Owner’s Representative, re-shape and compact the subgrade in accordance with the steps outlined above.

3.1 INSPECTION AND TESTING:

A. Prior to placement of any subbase gravel, the Owner’s Representative shall be contacted to review subgrade conditions and observe a proof roll with a loaded tandem dump truck.

B. See 1.3 and 1.4 of this Section for required tests and test reports.

3.2 GEOTEXTILE INSTALLATION:

A. General: Prior to placement of fabric, prepare grade to a smooth surface, free from obstructions and depressions which could result in tearing or puncturing of the fabric.

B. Placement: The fabric shall be unrolled as loosely and positioned as smoothly as possible on

the surface to minimize wrinkles and folds. Overlap seams by 24 inches. Tension the fabric prior to and during complete covering.

C. Covering: Cover material shall be placed at the edges of the fabric and then pushed onto the fabric. The first layer shall be greater than 12 inches and first compacted by a tracked bulldozer. Do not allow equipment directly on fabric without cover material in place.

D. Protection: Fabric shall be protected from rain, sunlight, dust, mud, debris, or other elements which may affect its performance. Remove and replace damaged fabric. Do not allow fabric to be exposed more than 5 days.

3.3 GRAVEL SUBBASE:

A. Obtain acceptance from Owner's Representative of gravel material prior to delivery to the site.

B. On prepared approved subgrade or (geotextile fabric as indicated on the plans), construct gravel subbase to conform to details on Drawings and these Specifications. Gravel shall consist of sound gravel particles free of thin shale, clay or organic material, with no stone over 4" in size, as specified herein.

C. Construct subbase in one course when compacted depth required is 12" or less and two or more courses when depth required is over 12". Compact each course to 95% of maximum laboratory density (ASTM-D2922: Nuclear Method Density). Course thicknesses required are after compaction.

3.4 AGGREGATE SURFACE COURSE:

A. Obtain acceptance from Owner's Representative of aggregate material prior to delivery to the site.

B. On compacted subbase, construct aggregate surface course to lines and grades to conform with details on Drawings and these Specifications. Material shall be as specified herein. Coordinate base course construction with adjacent pavers or curb installation when present.

C. Construct base in one course when compacted depth required is 6" or less and two or more courses when compacted depth required is over 6". Compact each course to 95% of maximum laboratory density (ASTM D2922: Nuclear Method Density). Thickness required is after final compaction.

3.5 GRADING: Comply with Section 312300 – Site Earthwork.

END OF SECTION

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SECTION 321200
BITUMINOUS CONCRETE PAVEMENT

PART 1 - GENERAL

1.0 DESCRIPTION (VAOT Division 400 & 700): This work shall consist of constructing one or more courses of bituminous mixture on a prepared foundation in accordance with these specifications and the specific requirements of the type of surface being placed, and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer. Furnish all labor and materials required to complete all paving of parking and circulating drives.

PART 2 - MATERIALS

2.0 GENERAL:

A. Materials shall meet the requirements of the following subsections of Division 700 – Vermont Standard Specifications for Construction dated 2018:

1.	Asphalt Cement	702.02
2.	Emulsified Asphalt, RS-1	702.14
3.	Aggregate for Bituminous Concrete Pavement	704.10

The grade of Asphalt Cement shall be AC20 unless otherwise specified in the contract. The grade of asphalt may be changed by the Engineer upon one week's notice.

2.1 SUBMITTALS: Marshall method Mix Design including test details for all mixes used for heavy duty Bituminous Concrete Pavement.

A. Results of nuclear density meter testing for every 500 s.f. of area base and top paving (92% minimum, 94% maximum of daily average maximum specific gravity).

B. Truck delivery slips showing weight of Bituminous Concrete Pavement delivered.

2.2 TESTING: The Owner shall retain a testing laboratory/company(2) to perform testing as required or indicated. Reports of findings or inspections will be distributed directly to the Owner and Contractor. In the event any test or inspection reveals that the materials or method do not live up to the contract documents, a re-test(s) will be required. The cost of such re-test(s) will be borne by the Contractor. Contractor shall notify Owner and testing agency 24 hours in advance of readiness or need for testing to allow for testing to be accomplished.

2.3 COMPOSITION OF MIXTURE:

A. Gradation: The materials hall be combined and graded to meet the composition limits for each of the pavement types in conformance with the State of Vermont Agency of Transportation "Standard Specifications for Construction" dated 2018.

B. Design Criteria: The materials shall be combined and graded to meet the following criteria:

DESIGN CRITERIA

MARSHALL Test Properties	Medium Duty Bit. Concrete Pavement 50 blows/side	Heavy Duty Bit. Concrete Pavement 75 blows/side
VMA % Type III VMA % Type IV	15.0 min. 16.0 min.	15.0 min. 16.0 min.

C. Air Voids: The percent of air voids of the mixture shall be calculated by the following formula:

1. (F = 100 (R-P)/R) where:

   a. F = % voids in compacted mixture

   b. R = Maximum specific gravity of uncompacted mixture (AASHTO T 209)

   c. P = Bulk specific gravity of compacted mixture (AASHTO T 166, Method B)

2. Unless specifically designated on the plans, all bituminous concrete pavement shall be designed in conformance with the design criteria for Heavy Duty Bituminous Concrete Pavement.

3. Unless otherwise specified for highways, Type I shall be used for base course, Types I or II shall be used for binder course and Types II, III, or IV shall be used for wearing course.

4. Type V mix will be designed to meet the gradation criteria of 406.03(a) only. The mix design shall have a filler/asphalt ratio ranging between 0.50 and 1.20.

D. Mix Design: The Marshall Method of Mix Design will be used to develop a mix that will meet the Design Criteria. A copy of all test data, including graphs, used in developing the mix, may be required with the submittal of the mix design.

1. The job-mix formula for each mixture shall establish a single percentage of aggregate passing each sieve and a single percentage of bituminous material to be added to the aggregate. No change in the job-mix formula may be made without written approval of the Engineer. The job-mix formula must fall within the master range of the specification as shown in 406.03(a).

2. No work shall be started until the Contractor has submitted and the Engineer has approved a mix design including cold feed and not bin gradings, mixing times, the percentage of each ingredient including bitumen, the job-mix formula from such a combination, and the optimum mixing and compaction temperatures as required in the Marshall Method of Mix Design.

3. The Engineer may order a change in any part of the job-mix formula if placement, finishing or compaction characteristics are determined by the Engineer to be unsatisfactory.

4. At the time the above mix design is submitted, the Contractor shall indicate and make available for sampling and testing stockpiles of all aggregates and asphalt proposed for use.

5. A minimum time of two weeks shall be allowed for testing and evaluation of the submitted mix design. Once a mix design is approved, the job mix formula is valid until the producer makes a change in aggregate source, asphalt grade, or asphalt source.

E. Control of Mixtures: The plant shall be operated so that no intentional deviations are made from the job-mix formula by more than the following tolerances:

1. Testing Tolerances

a. Aggregate larger than 2.36 mm sieve	+/- 6.0%
b. Aggregate passing 2.36 mm sieve and larger than 75 *p*m	+/- 4.0%
c. Aggregate passing 75 *p*m sieve	+/- 1.0%
d. Temperature of Mixture	+/- 11°C

e. The quantity of asphalt cement introduced into the mixer shall be that quantity specified in the accepted job-mix formula and will be accepted on the basis of the mass on the printed weigh slip.

f. If an analyzed sample is outside of the testing tolerances and/or other design criteria, immediate adjustment shall be made by the Contractor. After the adjustment, the resulting mix will be sampled and tested for compliance with the specification. With the permission of the Engineer, the plant may continue production pending results of test, but if the Engineer deems it in the best interest of the project, the Engineer may at any time order plant production stopped. In this event, additional adjustments shall be made and tested on a trial basis until the deficiency is corrected.

2.4 WEATHER LIMITATIONS

A. Bituminous material shall not be applied between November 1 and May 1. The courses shall not be placed when the ambient air temperature at the paving site in the shade and away from artificial heat is below 5°C (40° F) for courses 35 (1 ¼ in) mm or greater in compacted thickness or below 10°C (50° F) for courses less than 35 (1 ¼ in) mm in compacted thickness.

B. Bituminous material shall not be placed on a wet or frozen surface or when weather or other conditions would prevent the proper handling, finishing, or compacting of the material, unless otherwise approved by the Engineer.

C. Bituminous wearing course materials shall not be applied before May 15 or after October 15.

D. When it is in the public interest, the Construction Engineer may adjust the ambient air temperature requirements or extend the dates of the paving season.

2.5 BITUMINOUS MIXING PLANT AND TESTING

A. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold storage bins. The storage yard shall be maintained neat and orderly and the separate stockpiles shall be readily accessible for sampling.

B. All existing plans shall be inspected each construction season by an authorized representative of the Owner. Written notification shall be given for any plant which has not been inspected so that an authorized representative of the Owner may inspect and approve said plant prior to any mixing operation for Agency of Transportation projects. A minimum of two weeks should be allowed for the scheduling of the inspections. The plant shall be in operation at the time of inspection.

C. Plants used for the preparation of bituminous mixtures shall conform to all requirements under (a), except that scale requirements shall apply only where mass proportioning is used. In addition, batch mixing plants shall conform to the requirements under (b); continuous mixing plants shall conform to the requirements under (c); and drum mixing plants shall conform to the requirements under (d).

D. Scales to be approved for the weighing of materials shall conform to the restrictions herein set forth and shall meet all specifications, tolerances and regulations which have been or may be adopted from time to time by the DIRECTOR OF STANDARDS OF THE VERMONT DEPARTMENT OF AGRICULTURE, and shall be subject to approval by the Engineer. The scales shall be checked and sealed as deemed necessary to assure accuracy.

E. Requirements for all Plants:

1. The plants shall be so designed, coordinated and operated as to produce a uniform mixture within the mix design fixed by the contract.

2. All plants shall have automatic controls which coordinate the proportioning, timing and discharge of mixture by the single operation of a switch or button. In addition to these controls, the plant will have an approved recordation system.

3. The recordation system shall be capable of printing the total net mass of the load. Each weigh slip will be automatically printed with the date and the time of batching and will show project and truck identification.

4. All originals of recorded data pertaining to the weighing or proportioning of bituminous concrete, after recordation, shall become the property of the Owner.

5. Truck Scales: Approved truck scales shall be provided at each plant. The scale platform shall be of such length and width that it will conveniently accommodate all trucks or other approved hauling equipment. The entire vehicle load must rest on the scale platform and be weighed as one draft.

   a. These scales may be used for spot checking the accuracy of the recordation equipment. Any variance exceeding 0.5% of the net mass shall result in immediate corrective action by the Contractor.

   b. A weatherproof building of sufficient size to house the scale operator and the inspector shall be provided. It shall have adequate lighting, both natural and artificial, and it shall be adequately and safely heated.

   c. If the Contractor’s printer breaks down, the Contractor may continue to operate for the remainder of that day, provided the following conditions are met:

      1) The Resident Engineer grants permission to operate.

      2) The Resident Engineer assigns an Inspector to record the total aggregate and asphalt mass for each batch on the appropriate ticket.

6. Equipment for Preparation of Bituminous Material: Ranks for storage of bituminous material shall be insulated and capable of heating the material, under effective and positive control at all times, to the temperature requirements set forth in the specifications. The heating system shall provide uniform heating of the entire contents of the tanks. Heating shall be accomplished by steam or oil coils, electricity, or other means so that no flame shall come in contact with the heating tank.

a. A circulating system for bituminous material shall be of adequate capacity to provide proper and continuous circulation between storage tank and the proportioning units during the entire operating period.

b. The discharge end of the circulating pipe shall be maintained below the surface of the bituminous material in the storage tank to prevent discharging hot bituminous material into the open air.

c. All pipe lines and fittings shall be steam or oil jacket or otherwise properly insulated to prevent heat loss.

7. Feeder for Dryer: The plant shall be provided with an accurate mechanical means for uniformly feeding the mineral aggregate into the dryer so that uniform production and uniform temperatures will be obtained.

8. Dryer: The dryer shall be capable of heating and drying the mineral aggregates to specification requirements without leaving any visible unburned oil or carbon residue on the aggregate when it is discharged from the dryer. Black smoke from the exhaust stack shall not be permitted. Drying shall continue until all moisture is removed. If unusually wet aggregate is being used, the input to the dryer shall be reduced to that amount which the dryer is capable of drying.

9. Screens: Plant screens shall have the capacity and size range to separate the aggregates into sizes for proportioning so that they may be recombined within the limits of the specifications. The screen over the “fines bin” shall have a maximum square opening of 5.0 mm. Slotted screens may be used when approved by the Engineer. Screens are not applicable to drum-mix plants.

10. Cold Storage Bins: The plant shall have cold storage of sufficient capacity to ensure a uniform and continuous operation.

    a. The bins shall be so constructed as to prevent any intermingling of aggregates from one bin to another. The use of loaders or trucks which are larger in width than the bins being charged shall not be allowed. The blending of two or more aggregates in the same bin will not be permitted.

    b. For all bituminous concrete supplied for use on Owner projects, uniform feeding of all fine aggregates shall be accomplished by the use of a variable speed continuous belt feeder on each cold storage bin of fine aggregate.

11. Hot Bins: The plant shall include hot storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. The hot storage shall consist of at least four bins arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

    a. When the material in any bin contains more than 15% of material which is under size for that bin, based on the sieve analysis of hot bins used in determining the job-mix formula, the bins shall be emptied and correction of the cause for such condition shall be made.

    b. Each bin shall be provided with a free flowing overflow pipe that shall be of such size and at such a location as to prevent any backing up of material into other bins or into contact with the screen … this overflow material shall not be fed back into the system or into any accepted stockpiles.

c. Bins shall be equipped with sensor devices to indicate the position of the aggregate in the bins at the lower quarter point. An automatic plant shutoff device shall be provided to interrupt the batching process when any aggregate bin becomes empty.

d. Adequate additional dry storage shall be provided when mineral filler is required. The system shall have a device to feed the mineral filler accurately and uniformly at adjustable rates consistent with the percent required. The feeder shall be interlocked in such a manner that production is interrupted if the bin becomes empty or the flow is obstructed.

e. Adequate and convenient facilities shall be provided to make possible the obtaining of representative aggregate samples from each bin.

f. Hot bins are not applicable to drum-mix plants.

12. Bitumen Control Unit: Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bitumen. Metering devices for bitumen shall indicate accurately to within plus or minus two percent the amount of bitumen delivered when tested for accuracy.

    a. The section of the bitumen flow line between the charging valve and the spray bar shall be provided with a three-way valve and outlet whereby the rate of delivery of the metering device may be checked by actual mass.

    b. Suitable means shall be provided, either by steam or oil-jacketing, or other insulation, for maintaining the specified temperatures of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers of flow lines.

13. Thermometric Equipment: An armored thermometer shall be fixed in the bituminous feed line at a suitable location near the discharge valve at the mixer unit to accurately indicate the temperature of the bitumen.

    a. The plant shall be further equipped with approved recording thermometer, pyrometers, or other approved recording thermometric instruments placed at the discharge chute of the dryer.

    b. The Engineer reserves the right to pass upon the efficiency of the thermometric instruments and, for better regulation of the temperatures of aggregates, may direct replacement of any instrument by an approved temperature recording apparatus and may further require that daily temperature charts be filed with the Engineer.

14. Control of Mixing Time: The plant shall be equipped with positive means to govern the time of mixing and to maintain a constant mixing time unless changed by order of the Engineer.

15. Dust Collectors: The plant shall be equipped with adequate dust collectors so that objectionable exhaust will not be dissipated into the atmosphere. Provisions shall be made to waste or uniformly reintroduce all or any part of the heavier dust particles from primary collectors into the flow of aggregate.

    a. The introduction of baghouse fines into all bituminous concrete mixes will be allowed when the fines are introduced by an approved metering or weighing system which introduces the fines under positive uniform control.

    b. The Engineer has the authority to withdraw the approval for use of baghouse fines at any time that the bituminous concrete pavement mix provided by the Contract is unsatisfactory as determined by the Engineer.

16. Testing Facilities: The Contractor shall provide a weatherproof building with at least 22 square meters of floor space, in which to house and use the testing equipment. This building shall be maintained for the use of the Owner, Engineers or Inspectors, and shall be so located that details of the Contractor's plant are plainly visible from one window of the building.

    a. Adequate lighting, heating and electrical connections shall be provided for a 24-hour day. Proper means for ventilation shall be provided. The method of heating shall be such that a minimum temperature of 21°C will be maintained at all times. Sanitary toilet facilities with lavatory, with proper sewage disposal, shall be furnished for the use of Owner personnel. Cleaning supplies shall be furnished by the Contractor. A private telephone service shall be provided in the laboratory.

    b. A trailer type mobile laboratory may be used in conjunction with a temporary plant only. Any plant that occupies or has occupied the same location for more than one year will be classified as a permanent plan and will require a permanent building for a laboratory.

17. Safety Requirements: Adequate and safe stairways to the mixer platform shall be provided and guarded ladders to other plant units shall be located where required for accessibility to plant operations.

    a. All heated pipe lines adjacent to the work areas, gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected.

    b. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck-loading space. This space shall be kept free of drippings from the mixing platform. A platform shall be so located at the truck loading space as to permit easy and safe inspection of the mixture as it is delivered into the trucks. Adequate overhead protection shall be provided where necessary.

18. Surge Bins: Surge or storage bins will be permitted for use in the production of bituminous items provided they are approved and inspected by the Engineer. They will be capable of storing the mix without any degradation of its properties. Provision will be made to cover the surge or storage bins during inclement weather to protect the stored mix from the elements. Should circumstances preclude paving operations, the Owner will not be obligated to purchase mix remaining in a surge or storage bin.

    a. For continuous and drum-mix plants, an approved recording weigh system shall be used on all surge bins.

    b. When a surge bin is used in conjunction with a batch plant, the determination of pay quantities for this item shall be in accordance with the following procedure:

        1) The plant will produce mix with the printer in operation conforming to the standard requirements for this device. The mix will be deposited in the surge bin. A sequentially numbered ticket will be prepared for every normal load produced.

        2) As each truck is loaded from the surge bin, the driver will be given the ticket previously prepared when the mix was produced for that bin. The truck drive will then deliver the ticket to the paving Inspector upon reaching the paving site.

        3) The mass shown on the ticket will not be the actual mass of the mix contained in the truck since the truck was loaded from the surge bin. The bin will be completely emptied

at the end of every day, circumstances permitting, and all tickets delivered to the paving Inspector.

4) Rejected or held over material, if encountered, will be weighed on the platform truck scales and this quantity deducted from the daily totals.

5) When paving ramps or other areas where a definite quantity is desired, the material required for these areas will be weighed on the platform scales and appropriate adjustments made in the daily totals obtained from the printer. These masses will be entered on the ticket or a separate ticket provided.

6) The plant Inspector will sign the first slip of each day instead of initialing it. If there is a change in inspectors during the day, this procedure should be followed for each change in Inspectors. At the end of each day, the plant Inspector will inspect the storage bin to determine that it is empty and so note on the last slip.

7) The paving Inspector will acknowledge receipt of the material at the paving sites by initialing the lower right-hand corner of the ticket.

8) All standard checks of the weighing apparatus on the plant will be made at the prescribed intervals.

9) All misproduced material for commercial customers and/or other projects must be discharged from other bins or directly from the pugmill into the haul vehicle and not loaded from the bin.

10) All surge bins shall be emptied each day unless written permission is obtained from the Engineer.

19. Requirements for Batching Plants:

a. Weigh Box or Hopper: The equipment shall include a means for accurately weighing each bin size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over.

1) The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they will not be easily thrown out of alignment or adjustments.

2) All edges, ends and sides of weighing hoppers shall be free from contract with any supporting rods of columns or other equipment that will in any way affect proper functioning of the hopper. Also, there shall be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials.

3) The discharge gate of the weigh box shall be so hung that the aggregates will not be segregated when dumped into the mixer. The gate shall close tightly when the hopper is empty so that no material will be allowed to leak into a batch in the mixer during the process of weighing the next batch.

20. Aggregate Scales: Scales for any weigh box or hopper shall be of the springless dial type or load call with digital readout and shall be of standard make and design sensitive to 0.1% of the maximum load that may be required. Dials will be free of vibration and shall be so located as to be plainly visible and readable to the operator at all times.

a. Adequate means for checking the accuracy of the scales shall be provided by the Contractor either by the use of ten 20 kg test masses or by other methods approved by the

Engineer. All test masses will be certified annually by the Division of Weights and Measures.

21. Bitumen Bucket: The bucket for weighing bitumen shall be of sufficient capacity to hold and weight the amount required for a batch in a single weighing.

    a. The filling system and bucket shall be of such design, size and shape that bitumen will not overflow, splash and spill outside the confines of the bucket during filling and weighing.

    b. The bucket shall be steam or oil-jacketed or equipped with properly insulated electric heating units. It shall be so arranged as to deliver the bitumen in a thin uniform sheet or in multiple sprays over the full length of the mixer within a period of 15 seconds.

22. Bitumen Scales: Scales for weighing of bituminous material shall conform to the specifications for the scales for aggregate. The value of the minimum graduation shall not be greater than 1.0 kg.

23. Mixer Unit for Batch Method: The plant shall include a batch mixer of an approved twin pugmill type, jacketed or insulated and capable of producing a uniform mixture within the job-mix tolerance fixed by the contract. The mixer shall be so constructed as to prevent leakage and designed to provide a means of adjusting clearance between the mixer blades and liner plates.

24. Recordation: The recordation system of the batch plant shall print the mass of the bitumen; mass of the aggregate; and the total combined mass of both in addition to printing the combined net mass of each load.

25. Requirements for Continuous Mixing Plants:

    a. Aggregate Proportioning: The plant shall include means for accurately proportioning aggregate from each bin, by mass. The unit shall include interlocked feeders mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to control the rate of flow of aggregate from each bin compartment. The opening shall be rectangular, with one dimension adjustable by positive mechanical means. Locks shall be provided on each gate. Calibrated gauges with minimum graduations of not more than 2.5 mm shall be provided for each gate to establish gate openings.

    b. Calibration of Aggregate Feed: The plant shall include a method for calibration of gate openings by means of test samples. The materials fed out of the bins through individual openings shall be bypassed to a suitable test box, each compartment material being confined in a separate box section. The plant shall be equipped to handle conveniently such test samples with a mass of up to 365 kg and to weigh them on accurate scales.

    c. Synchronization of Aggregate Feed and Bituminous Feed: Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source. This control shall be accomplished by interlocking mechanical means or by any positive method under the Engineer's control.

    d. Mixer: The plant shall include a continuous mixer of an approved twin pugmill type, insulated or jacketed, and capable of producing a uniform mixture within a job-mix tolerance fixed by the contract. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall carry a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge and also giving the rate of feed of aggregate per minute, at plant operating speed.

1) Unless otherwise required, determination of mixing time shall be by the following formula:

Mixing time in seconds = Pugmill dead capacity in kilograms / Pugmill output in kilograms per second.

e. The masses shall be determined for the job by tests made under the direction of the Engineer.

26. Requirements for Drum Mix Plants:

a. Aggregate Cold Bin Feeders: The plant shall have a device at each cold bin to feed the aggregate accurately and uniformly. The feeding orifice shall be adjustable. No gravity type feeders will be permitted. Indicators graduated to not more than 2.5 mm shall be provided on each orifice. Each aggregate feeder shall be interlocked in such a manner that production is interrupted if one or more cold bins become empty or the flow is obstructed.

b. Mineral Filler System: When mineral filler is to be added, it shall be fed from a bin and feeder separate from the aggregate cold bins. The system shall have a device to feed the mineral filler at adjustable rates accurately and uniformly.

c. The feeder shall be interlocked in such a manner that production is interrupted if the bin becomes empty or the flow is obstructed. The filler shall be fed in a manner such that no filler is lost in the form of fugitive dust.

d. Aggregate Weighing Equipment: All aggregates including mineral filler shall be weighed by a continuous weighing device either as it is proportioned by the individual feeders or after all materials have been deposited on a common belt. Belt scales shall meet the requirements of National Bureau of Standards Handbook 44 and they shall be installed according to the scale manufacturer's recommendations by a technician licensed by the Division of Weights and Measures. Any other weighing device shall be submitted for approval by the Engineer.

e. Bitumen Control Unit: The bitumen shall be proportioned by a meter. A flow switch designed to interrupt production if the bitumen flow is discontinued shall be installed in the delivery line between the meter and the mixer. A temperature compensating device shall be installed in conjunction with the meter to correct the quantity of asphalt to 16°C.

27. Proportioning Controls: All proportioning controls for aggregates, including mineral filler, and bitumen shall be located at the panel which also controls the mixer and temperature. The panel shall have a master control which will increase or decrease the production rate without having to reset the individual controls for each change in production rate.

a. Aggregate Feed Rate Control: The plant shall have an adjustable feed rate control for each aggregate cold bin feeder and mineral filler feeder. The control shall maintain an aggregate flow accuracy such that the variation of material per interval of time shall not exceed an amount equal to 1.5% of the total mass of bituminous mixture per interval of time. Where the separate addition of mineral filler is required, it shall be added with an accuracy of 0.5% on the basis stated above the aggregates. The rate of aggregate flow shall be displayed on a meter and it shall be based on mass or percentage of dry aggregates.

b. Aggregate Mass Indicator: An aggregate mass indicator shall display in the control room the mass of combined aggregates and mineral filler and it shall continuously accumulate

the mass of material during the production period in the day. The mass indicated shall be dry aggregate mass. The indicator shall be resettable to zero and lockable.

c. Aggregate Moisture Compensator: A moisture compensation device shall be capable of electronically changing the wet mass of aggregate to dry aggregate mass. The compensator may be set manually based on moisture tests performed on composite aggregate samples. The maximum graduations on the compensator shall be 0.1%.

d. Bitumen Control: The bitumen control shall be capable of presetting the actual bitumen content directly as a percentage based on total mass of mixture. The maximum graduation on the bitumen control shall be 0.1%. The asphalt delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies.

e. Bitumen Quantity Indicator: A bitumen quantity indicator shall display in the control room the accumulated quantity of bitumen during the production period in the day. The quantity indicated may either mass or volume at 16°C. The indicator shall be resettable to zero and lockable.

28. Recordation of Proportions: The plant shall be equipped with an automatic digital recording device approved by the Engineer that simultaneously records the accumulated mass of dry aggregate and bitumen separately during production time and on demand. All recordings shall show the date, including day, month, and year, and time to the nearest minute for each print. The original recordings shall become the property of the Owner.

29. Calibration of Feed Rates: The feed rates of aggregates from the cold bins, mineral filler when used, and bitumen shall be established for each mix type initially by passing the individual aggregates and mineral filler over the continuous weighing device and the bitumen through the meter respectively. The feed rates shall be checked periodically or at the direction of the Engineer.
30. Automatic Aggregate Sampling Device: An automatic aggregate sampling device shall be provided which will divert a representative combined aggregate sample, including mineral filler, into a hopper or container for such purpose of gradation testing. The sampling tray shall cut the full width and depth of the aggregate flow. The sampling point shall be after the aggregate is proportioned and prior to its mixing with bitumen.

31. Mixer Unit: The plant shall include a drum mixer of a type approved by the Engineer having an automatic burner control and capable of producing a uniform mixture with the job-mix tolerances. The mixture shall be discharged into a hot bituminous mixture holding bin meeting the requirements of 406.05(1), part 14, Surge Bins.

PART 3 - EXECUTION

3.0 PREPARATION OF BITUMINOUS MATERIAL:

A. The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide continuous supply of the bituminous material to the mixture at a uniform temperature at all times.

3.1 PREPARATION OF AGGREGATES:

A. The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid soot or unburned fuel on the aggregate.

B. The aggregates, immediately after heating, shall be screened and conveyed into separate bins ready for batching and mixing with bituminous material.

C. Mineral filler, if required to meet the grading requirements, shall be added in a manner approved by the Engineer after the aggregates have passed through the dryer.

D. The above preparation of aggregates does not apply for drum-mix plants.

3.2 MIXING:

A. The dried aggregates shall be combined with the bituminous material in such a manner as to produce a mixture which, when discharged from the mixing unit, shall be at the temperature specified on the approved mix design unless otherwise directed by the Engineer.

B. The dried aggregate shall be combined in the mixer the in amount of each fraction of aggregate required to meet the job-mix formula and thoroughly mixed prior to adding the bituminous material.

C. The bituminous material shall be measured and introduced into the mixer in that amount determined by the Engineer for the particular material being used and at a temperature directed by Engineer.

D. After the required amounts of aggregate and bituminous material have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured. In any event, the mixing time shall be regulated by the Engineer and a suitable locking means shall be provided for such regulations.

E. All plants shall have a positive means of eliminating oversize and foreign material from being incorporated into the mixer.

3.4 HAULING EQUIPMENT:

A. Trucks used for hauling bituminous mixture shall have tight, clean, smooth metal beds which have been thinly coated with a non-petroleum based or soap solution to prevent the mixture from adhering to the beds.

B. Each truck shall have a cover of canvas or other suitable material of such size sufficient to protect the mixture from the weather. When necessary to assure delivery of material on the road at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

3.5 PLACING EQUIPMENT:

A. The bituminous concrete paver shall be a self-propelled unit with an activated screed or strike-off assembly, capable of being heated if necessary and will be capable of spreading the mixture without segregation for the widths and thicknesses required. The screed shall be adjustable to provide the desired cross sectional shape. The finished surface shall be of uniform texture and evenness and shall not show tearing, shoving, or pulling of the mixture. The machine shall at all times be in good condition and shall be operated by competent personnel.

B. Pavers shall be equipped with the necessary attachments, designed to operate electronically, for controlling the grade of the finished surface.

C. The adjustments and attachments of the paver shall be checked and approved by the Engineer before placing of bituminous material.

3.6 ROLLERS:

A. Rollers shall be in good mechanical condition, operated by competent personnel, capable of reversing without backlash, and operated at speeds slow enough to avoid displacement of the bituminous mixture. The mass of the rollers shall be sufficient to compact the mixture to the required density without the crushing of the aggregate. They shall be equipped with tanks and sprinkling bars for wetting for the rolls or tires.

B. Rollers shall meet the following requirements:

1. Two-axle tandem roller shall have a gross mass of not less than 7.25 t and not more than 10.85 t and shall be capable of providing a minimum compactive effort of 44 kN/m of width of the drive roll. All rolls will be at least 1.06 m in diameter.

2. Three-axle tandem roller shall have a gross mass of not less than 10.85 t and not more than 18.10 t and shall be capable or providing a minimum compactive effort of 44 kN/m of width of the drive roll. The roller shall be equipped with a locking device to allow the center axle roll to move independently or be secured in a locked position.

3. Pneumatic-tired rollers shall be self-propelled and equipped with a minimum of seven wheels situated on the axles in such a way that the rear group of tires will not follow in the tracks of the forward group, but shall be spaced so that a minimum tire path overlap of 13 mm is obtained. The wheels on the least one of these axles will be capable of oscillating in a vertical direction, either individually or in pairs. The tires shall be of equal size. The compressor for inflation of tires shall be capable of inflating the tires so that the air pressure between tires does not very more than 34 kPa. The tires shall be smooth and capable of being inflated to a pressure necessary to provide ground contact pressure of at least 550 kPa per tire. The Contractor shall provide a gauge at all times to enable the Engineer to check tire pressures. Appropriate charts or tables shall be posted on each roller showing the contact areas and contact pressures for the full range of tire inflation pressures and wheel loadings for the type and size of the roller and tires involved.

4. Vibratory rollers shall be separate controls for energy and propulsion. They shall be equipped with automatic cutoffs that stop the vibration when the roller is stopped or reversing its direction of travel.

3.7 CONDITIONING OF EXISTING SURFACE:

A. The existing surface shall be cleaned and sprayed with Emulsified Asphalt, RS-1, before placing of the bituminous mixture except that when the surface to be paved is placed in the same construction season, the asphalt treatment will not be a requirement unless ordered by the Engineer. The emulsion shall be applied under pressure at the rate of 0.05 to 0.14 L/m^2. The application shall be made just prior to the placement of the bituminous concrete mixture but shall progress sufficiently ahead of the paving so that the surface to be paved will be “tacky”. Equipment used to apply the emulsion shall meet the requirements for distributors under subsection 404.04, Equipment.

B. Bridge floors shall be treated as detailed on the project plans, prior to paving.

C. When the bottom course of Bituminous Concrete Pavement is left over the winter or paving is to be made over an existing cement concrete pavement or bituminous concrete pavement, the existing surface shall be cleaned and Emulsified Asphalt applied as described above before the next course is applied.

D. All longitudinal and transverse joints and all cracks shall be sealed by the application of an approved joint sealing compound before spreading the mixture upon a Portland cement concrete

surface. All excess bituminous material shall be removed from joints and cracks prior to placing the bituminous concrete mixture.

E. Any large cracks in a bituminous surface shall be thoroughly cleaned and filled with bituminous material or mixture approved by the Engineer.

F. Contact surfaces such as curbing, gutters and manholes shall be painted with a thin, uniform coat of Emulsified Asphalt, RS-1, immediately before the bituminous concrete mixture is placed against them.

G. If there are deficiencies that require corrective action in the base course constructed as part of the contract, a bituminous concrete mix which meets the approval of the Engineer shall be used to bring the base course to the designed grade and contour.

H. Where Bituminous Concrete Pavement is used to resurface existing pavements and the existing pavement contains irregularities, depressions or waves, such deficiencies shall be eliminated by the use of extra bituminous material for leveling to bring existing base to uniform section and grade before placing of the required course of bituminous concrete.

3.8 PLACING AND FINISHING:

A. The bituminous mixture, at the time of discharge from the haul vehicle, shall be within 6°C of the compaction temperature for the approved mix design.

B. The Contractor shall protect all exposed surfaces, which are not to be treated, from damage during all phases of the paving operation.

C. The bituminous mixture shall be placed and finished with the specified equipment and struck off in a uniform layer to the full width required and of such depth that each course, when compacted, shall have the required thickness and shall conform to the grade and elevation specified. Bituminous pavers shall be used to distribute the mixture over the entire width or over such partial width as may be practical.

D. When operation in tandem on multi-lane paving, the pavers shall be of the same type and characteristics. Material for leveling may be spread by the use of a grader, if approved by the Engineer.

E. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked and luted by hand tools.

F. No material shall be produced so late in the day as to prohibit the completion of spreading and compact of the mixture during daylight hours, unless night paving has been approved for the project.

G. No traffic will be permitted on material placed until the material has been thoroughly compacted and has been permitted to cool to 60°C.

H. The use of water to cool the pavement will not be permitted.

I. The Owner reserves the right to require that all work adjacent to the pavement, such as guardrail, cleanup and turf establishment, is completed prior to placing the wearing course when such work could cause damage to the pavement.

J. Suitable aprons to transition approaches where required shall be placed at side road intersections and driveways as directed by the Engineer.

3.9 COMPACTION:

A. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

B. The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving.

C. The number, mass and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in the workable condition. Generally, one breakdown roller will be needed for each paver used in the spreading operation.

D. Leveling courses shall be compacted using a self-propelled pneumatic-tired roller unless otherwise directed in writing by the Engineer. On base, binder, or wearing course, the initial or breakdown rolling shall be done by using a two-axle tandem roller; intermediate rolling by using a two-axle tandem roller or self-propelled pneumatic-tired roller; and final rolling by using an additional two or three-axle tandem roller. An intermediate roller will not be required for shoulders constructed with one course of bituminous concrete, but the equipment shall be sufficient to obtain the required compaction while the mixture is in a workable condition.

E. To prevent adhesion of the mixture to the rolls, they shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

F. Along forms, curbs, headers, walls and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot or lightly oiled hand tampers, smoothing irons or with mechanical tampers. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

G. Other combinations of rollers and/or methods of compacting may be used if approved in writing by the Engineer, providing the compaction requirements are met.

H. Unless otherwise directed, the longitudinal joint shall be rolled first and then rolling shall begin at the low side of the pavement and proceed towards the center of high side with lapped rollings parallel to the centerline. The speed of the roller shall be slow and uniform to avoid displacement of the mixture and the roller should be kept in as continuous operation as practicable. Rolling shall continue until all roller marks and ridges have been eliminated.

I. Roller will not be stopped or parked on the new, freshly placed mat.

J. The density of the compacted pavement shall be at least 92%, but not more than 96% of the corresponding daily average maximum specific gravity. Values which fall outside of this range will require the Contractor to take immediate corrective action.

K. It is the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by the Owner’s personnel.

L. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bitumen shall be removed and replaced. These replacements shall be at the Contractor’s expense.

M. The Contractor shall replace the like material where cores are removed during hot mix operations. These replacements shall be at the Contractor’s expense.

N. Should the Contractor choose to use vibratory rollers, the following additional criteria shall govern their operation: Vibratory rollers may be used when operated at an amplitude, frequency and speed that produces a mat conforming to specifications and which prevent the creation of transverse ridges in the mat. Vibratory rollers may be used as a breakdown roller, an intermediate roller, or a finish roller. They shall not be used as a substitute for a pneumatic-tired roller on leveling courses, nor shall they be used for compacting lifts of pavement under 25 mm in depth. One single vibratory roller shall not be used alone as the breakdown, intermediate and finish roller, but may be used as any one of the rollers in the roller train.

O. If the Engineer determines that unsatisfactory compaction or surface distortion is being obtained or damage to highway components and/or adjacent property is occurring using vibratory compaction equipment, the Contractor shall immediately cease using this equipment and proceed with the work in accordance with the fourth paragraph of this subsection.

P. The Contractor assumes full responsibility for the cost of repairing all damages which may occur to highway components and adjacent property, if vibratory compaction equipment is used.

3.10 JOINTS:

A. Joints between old and new pavements or between successive day's work shall be made so as to insure a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a joint constructed.

B. Butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at a location approved by the Engineer, where the pavement has a true surface as determined by the use of a straightedge at least 4.9 m long. The butt joint shall be thoroughly coated with Emulsified Asphalt, Type RS-1, just prior to depositing the paving mixture.

C. Tapered joints shall be formed by ramping down the last 450 to 600 mm of the course being laid to match the lower surface. Care shall be taken in raking out and discarding the coarser aggregate at the low end of the taper, and in rolling the taper. The taper area shall be thoroughly coated with Emulsified Asphalt, Type RS-1, just prior to resuming paving. As the paver places new mixture on the taper area, an evenly graduated deposit of mixture will complement the previously made taper. Shovels may be used to add additional mixture if necessary. The joint shall be smoothed with a rake, coarse material discarded, and properly rolled.

D. Longitudinal joints that have become cold shall be coated with Emulsified Asphalt, Type RS-1, before the adjacent mat is placed. If directed by the Engineer, they shall be cut back to a clean vertical edge prior to painting with the emulsion.

E. Unless otherwise directed by the Engineer, longitudinal joints shall be offset at least 150 mm from any joint in the lower courses of pavement. Transverse joints shall not be constructed nearer than 300 mm from the transverse joints constructed in lower courses.

3.11 SURFACE TOLERANCES: The surface will be tested by the Engineer using a straightedge at lest 4.9 m long at selected locations parallel with the centerline. Any variations excessing three millimeters between any two contacts shall be satisfactorily eliminated. A straightedge at least three meters in length may be used on a vertical course.

3.12 TRAFFIC CONTROL: Traffic control for any cold planing, paving or site work shall be the responsibility of the Contractor. Traffic control plans shall be submitted to and approved by the Site Engineer.

3.13 COMPACTION:

A. The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction. Generally, one 10 ton (9072 kg) breakdown roller will be needed for each paver used in the spreading operation.

B. The specific gravity of the compacted pavement will not be less than 92% and not more than 95% of the average daily maximum specific gravity of the type mix designated.

PART 4 - REFERENCE

A. All work related to the preceding specifications, unless otherwise noted, shall be accomplished in accordance with the State of Vermont Agency of Transportation “Standard Specifications for Construction”, dated 2018.

END OF SECTION

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SECTION 321243

VERMONT POROUS ASPHALT

PART 1 - GENERAL

1.0 SUMMARY

A. Furnish and place Porous Asphalt Pavement courses in accordance with the contract documents as directed by the Engineer-in-Charge. The top course mixture may require the use of Fibers as outlined in this specification. A Test Panel(s) may be required as outlined in this specification and other contract documents and will be called for in the Construction Plans and Details if applicable.

PART 2 – MATERIALS

2.0 MATERIALS

A. The materials and composition for the Porous Asphalt Pavement mixtures shall meet the requirements specified in Section 406 Bituminous Concrete Pavement of the Vermont Agency of Transportation Standard Specifications for Construction, except as noted herein.

Formulate a job mix formula (JMF) that satisfies the design limits listed below and submit it to the Engineer at least 14 days prior to placement of the test section or project paving. Proposed Mixing Temperatures and project specific draindown test results using the actual aggregates proposed for use shall also be included.

Porous Asphalt Pavement Mixtures Gradation Requirements

Screen Sizes	Top Course	Binder Course
	General Limits % Passing	General Limits % Passing
2 inch	—	100
1 1/2 inch	—	75-100
1 inch	—	55-80
3/4 inch	100	—
1/2 inch	85-100	23-42
3/8 inch	55-75	5-20
No. 4	10-25	2-15
No. 8	5-10	—
No. 16	—	—
No. 30	—	—
No. 200	2-4	—

Porous Asphalt Pavement Mixtures Design Criteria						
Mix	N_{design}	Air Voids @ N_{design}	PG Binder Content	VCA_{mix}[2]	Draindown of Uncompacted Asphalt Mixtures, AASHTO T305, maximum	Mixing Temperature Range[4] °F
Top Course	50	20.0	5.8 - 6.2%	Less than VCA_{drc}[3]	0.10 %	275 °F – 290 °F (290 °F max.)
Binder / Base Course[1]	35	25.0	2.5% - 4.5%	---	0.20 %	285 °F – 310 °F

Notes:

1. Sufficient PG Binder shall be used in the mixture such that **100%** of the aggregate particles are completely coated with binder as determined by AASHTO T195. In addition, when compacted in a gyratory compactor to 35 gyrations, the resulting specimen shall be stable and must not fall apart under its own weight.
2. VCAmix = The voids in the coarse aggregate fraction of the mix based on specimens compacted to Ndesign. The coarse aggregate fraction of the aggregate is that portion of the JMF aggregate skeleton not passing the No. 4 sieve.

$$VCA_{mix} = 100 - \frac{P_{ca} * G_{mb}}{G_{ca}}$$

Where: Pca = The percent of the coarse aggregate fraction by weight of total mix.

Gmb = The bulk specific gravity of the mix at the design PG Binder content as determined by AASHTO T275 or T331.

Gca = The bulk specific gravity of the coarse aggregate fraction as determined by AASHTO T85.

3. VCAdrc = The voids in the coarse aggregate fraction of the JMF aggregate skeleton, determined using the dry rodding technique according to AASHTO T19.

$$VCA_{drc} = \frac{100\ (G_{sbca}\gamma_w - \gamma_{ca})}{G_{sbca}\gamma_w}$$

Where: Gsbca = The bulk specific gravity of the coarse aggregate fraction as determined by AASHTO T85.

γ_{ca} = The unit weight of the coarse aggregate fraction (as determined by AASHTO T19.

Yw = The unit weight of water.

4. Or as specified by the PG Binder Supplier (no higher than 295 °F).

A minimum of 10 Working Days will be allowed for testing and evaluation of the submitted mix design. Once a mix design is approved, the job-mix formula is valid until a change is made in aggregate source or PG asphalt binder grade. If a change is made in aggregate source or PG asphalt binder grade, a new mix design shall be submitted and a minimum 10 Working Day evaluation period will be allowed prior to resuming production. If a change is proposed to be made in the PG asphalt binder supplier, it shall be from an approved supplier and be in accordance with the most current VTrans mix design submittal policy.

Bituminous Concrete Pavement Aggregates.

Use coarse aggregate meeting the requirements of Section 704-10, *Aggregate for Bituminous Concrete Pavement*.

Coarse aggregate for bituminous concrete pavement shall consist of clean, hard, crushed stone, crushed gravel, or crushed igneous rock, and be uniformly graded. The blending of crushed stone, crushed gravel, and/or crushed igneous rock may be permitted only in the binder / base course if, in the opinion of the Engineer, the materials to be blended are equal in quality and are compatible. All aggregate shall be free from dirt, deleterious material, and pieces which are structurally weak. "Coarse aggregate" shall mean that portion of material coarser than the No. 8 (2.36 mm) sieve.

Fine aggregate for bituminous concrete pavement shall consist of stone screenings or a combination of stone screenings, screened natural sand and/or manufactured sands, and other fine aggregates, such that at least 95% of any individual stockpile of the fine aggregate shall pass a 3/8 inch (9.50 mm) sieve. "Fine aggregate" shall mean that portion of material finer than the No. 8 (2.36 mm) sieve.

Performance-Grade (PG) Binder. Use polymer or terminal blend Crumb Rubber Modified (CRM) PG 76-28 Binder modified with SBS, in the production of the Top Course Porous Asphalt mixture. Use polymer or terminal blend CRM PG 70-28 Binder, in the production of the Binder / Base Course Porous Asphalt mixture.

The PG Binders shall meet the requirements of AASHTO M 332, *Standard Specification for Performance Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR),* for the production of the Porous Asphalt Pavement mixtures. In addition, the binder grade must also meet the **elastomeric** properties as indicated by one of the following equations for $\%R_{32}$:

For $J_{nr3.2} > 0.1$, $\%R_{3.2} > 29.371 * J_{nr3.2}^{-02633}$

For $J_{nr3.2} < 0.1$, $\%R_{3.2} > 55$

Where:

R_{32} is % recovery at 3.2 kPa

$J_{nr3.2}$ is the average non-recoverable creep compliance at 3.2 kPa

When terminal blend CRM PG binder is used, the following shall apply:

- Crumb rubber particles shall be finer than #30 sieve size.
- The terminal blend CRM PG binder shall be storage-stable and homogeneous.
- The Dynamic Shear Rheometer (DSR) shall be set at 2-mm gap.
- The terminal blend CRM PG binder shall be 99% free of particles retained on the 600 urn sieve as tested in accordance with Section 5.4 of M 332.

In addition, the PG Binder must meet the following requirements:

- Use of Polyphosphoric Acid (PPA) to modify the PG binder properties is prohibited for mixtures containing limestone, limestone as an aggregate blend component, or limestone as a constituent in crushed gravel aggregate. This prohibition also applies to the use of PPA as a cross-linking agent for polymer modification.

Reclaimed Asphalt Pavement (RAP). The use of RAP will not be allowed.

Mineral or Cellulose Fiber. Top Course Porous Asphalt Mixtures shall contain a mineral or cellulose fiber stabilizing additive. The dosage rate shall be approximately 0.2% to 0.6% depending on the fiber specifications by total mixture mass and sufficient to minimize or completely prevent draindown in accordance with the Porous Asphalt Pavement Mixtures Design Criteria above. The fibers must meet the properties in the table below.

Mineral Fiber Properties[1]

Property	Specification
Size Analysis	
Fiber Length [2]	0.25 in. maximum mean test value
Thickness [3]	0.005 mm maximum mean test value
Shot Content [4]	
Passing No. 60 sieve	90 ± 5%
Passing No.230 sieve	70 ± 10%

Notes:

1. The European experience and development of the above criteria are based on the use of basalt mineral fibers.
2. The fiber length is determined according to the Bauer McNett fractionation.
3. The fiber thickness, or diameter, is determined by measuring at least 200 fibers in a phase-contrast microscope.
4. Shot content is a measure of non-fibrous material. The shot content is determined on vibrating sieves. Two sieves, the 0.250 mm and the 0.063 mm, are typically utilized. For additional information, see AASHTO C612.

Please be Aware that fiber diameter has a significant effect on the workability of the asphalt and samples must be made to verify performance when using a new fiber source.

CONSTRUCTION DETAILS

The provisions of Section 406 shall apply except as modified herein.

Plant QC/QA. The QCT/QAT shall perform all testing required in Section 406 including air voids testing. Acceptance of the mixture quality will be based on aggregate gradation, asphalt binder content and porosity performance.

Plant Production. Top course mixture production: **The mixing time of the dry constituents of the mixture (aggregates and fibers) must be increased by a minimum of 20 seconds to 30 seconds when compared to conventional asphalt to ensure complete mixing of fibers and dry constituents.**

This is a requirement, not an option. Do not attempt to add fibers after asphalt binder introduction (wet mixing) clumping will occur and the load will be rejected when reaching the project site. Trucks shall be covered to help contain heat and reduce the potential for excessive cooling of the asphalt that is contacting the sides of the truck bed and or exposed along the top.

Paving.

Keep the porous asphalt pavement free of contamination from the construction operations. Take precautions as necessary such as washing truck tires, installation of silt fence, tarps on heavily traveled areas, etc. Stage the placement of the porous asphalt pavement after the surrounding areas have been final graded and stabilized to minimize potential sediment laden water from reaching the pavement surface.

Do not place the porous asphalt pavement top course on a wet surface or when the surface temperature is below 50° F. The target paving temperature of the asphalt is **275 to 290 degrees F**. Paving screeds must not be heated to more than **260 degrees F** and checked before each truck delivery to the paver hopper.

Internal Temperature Probes must be utilized in conjunction with non-contact thermometers. Temperatures of the surface and interior of the asphalt can vary by 60 degrees F.

If weather conditions are not within the guidelines presented below, a qualified, experienced professional in porous asphalt paving may provide guidance and/or modifications to the installation to allow paving in variable conditions. These must be determined on a case-by-case basis and will typically require additional equipment (rollers), labor power, methodology, and scheduling modifications.

General Ambient Air Temperature Guidelines

- Binder / Base Course - 40° to 70 °F and up to 80° with additional roller Ambient Temp **(Must have 45° Min Surface Temp)**
- Top Course - 50° to 80 °F. **No Paving Top Course w/ Ambient Temp under 50 °F.**
- Wind – up to 10 mph Pave @ 60° F. - Up to 20 mph pave @ above 65° F.
- In-Truck as delivered Temps – 250° - 300 °F for Binder / Base, 250° - 285 °F for Top
- **Use an Internal Temperature Probe** – to Verify Temperature. Reject truckload and placement of anything over 300 °F.

Inadequate dry mixing or improper introduction of fibers will show up as clumps in the asphalt that are typically white or tan. Each truck load must be inspected visually to ensure clumping is not present. If present, these loads must be rejected.

Do not use any type of solvent or kerosene, diesel fuel, gasoline etc. to clean tools. Scrapings from tools, boots, trucks, paver, etc. must not be discarded onto the asphalt surface or into the paver or trucks at any time. The use of Tack Coat will be prohibited. Prior to the placement of the Top Course, the Binder / Base Course must be cleaned to the satisfaction of the Engineer.

Place each course of porous asphalt pavement in one lift. Use a mechanical rubber track paver to place as much of the mix as possible. After completion of each pavement course, allow the pavement to cure for a minimum of 24 hours before placing the next course or allowing traffic of any kind on it. Exceptions for this requirement can be made when paving top course over the binder / base course. The binder / base course may be paved on when the surface temperature of the fresh mat is 90 °F or lower on the same day.

Parking lots require a 5 to 7 day period before parking on top course. Parking or driving by the public and non-project related personnel on binder / base course shall never be allowed as it will unravel and deteriorate quickly and run the risk of rejection and removal at the contractors or installers expense.

Rollers. A 10 ton to 12 ton double steel drum asphalt roller, with a minimum drum width of 54 inches, is required. The roller must be operated in static mode at all times. Operation of the roller in vibratory and/or oscillatory mode is prohibited. Pneumatic Tire rollers are prohibited. Do not stop the roller on the freshly placed mix for more than 30 seconds unless 2 passes have been made with the 10 to 12 ton asphalt roller at the temperatures listed below. Smaller rollers and plate tampers will be required as well.

GENERAL ROLLING REQUIREMENTS

- Begin Rolling the **Binder / Base Course** (SLOWLY) – from 220 to 240 °F…. Provide four (4) Passes with the 10 -12 ton double steel drum roller
- Begin Finish Rolling the Binder / Base Course with 10-12 ton double steel drum roller when Surface Temperature is 110 to 130 °F. as this will help achieve Target Density. Spikes in density occur between 110 to 130 °F.

- Roll **Top Course** (SLOWLY) from 200 to 240 °F. – Minimum of three (3) Passes with the 10 -12 ton double steel drum roller. **MUST be a 10-12T**. Use of a smaller roller will require special approval from Engineer and density gauge testing at the contractor's expense.
- Perform intermediate rolling of the Top Course with a 4 -8 ton asphalt roller as needed paying careful attention to surface temperatures not getting below 120 °F.
- VERY IMPORTANT - Roll the Top Course with the 10-12 ton roller when the Surface Temperature is 120 to 140 °F. Density Spikes of 3 to 5 lB/SF will occur in this temperature range and material should now reach Target Density.
- Finish roll as necessary with smaller rollers to remove "lines" and seams and joints marks.
- Do not attempt to roll the Top Course until the surface temperature is below 240 degrees F and roll it at least once before it reaches 200.

Minimum Temperatures for Rolling – To Reach Proper Density

- In all cases, each course MUST be rolled at least two (2) times when the surface temperature is between 110 and 130 degrees F to achieve design density. Multiple passes (up to 8) in this temperature range are permissible. Slow and steady and static will achieve best results.

Important: The asphalt is not compactable under 100 degrees F. Rolling under 100 degrees F will NOT take out "lines", even up seams or joints, or clean up curb edges and corners once the surface temperature reaches 100 degrees F.

- To develop centerline joints or other cold joints– meet previously paved edge with Hot Asphalt. Wait until temperature at edges equalize (min. 160° on hot side) or stops changing. Roll to Pinch Joint. Do not pre-heat the cold edge with a flame. If pre-heating is allowed by the Engineer in rare cases, temperatures of the heating device must not exceed 250 °F and must be a **non-flame** type source such as radiant heat.

- The final in-place air voids of the pavement layer shall be 16% to 20% for Top Course and 20 to 25% for Binder / Base Course. This will be determined by comparing the maximum achievable density to the in-place density as measured by a density gauge. The RICE number shall be provided by the production plant on a daily basis for multiple paving days.

Project Specific Rolling Requirements: If, by determination of the Engineer and Owner, the rolling requirements will not follow the General Rolling Requirements stated above, the Engineer will provide specific guidelines for rolling.

The owner will provide a density gauge operator that possesses a current Density Gauge Inspector Certification in accordance with the local or state requirements. The gauge operator will use the same gauge(s) used during the construction of the Test Panel if applicable. The density gauge operator will monitor the in-place density to ensure that the pavement is being compacted to the degree determined acceptable by the engineer. This requirement may be waived depending on project circumstances, experience with the material, and only as agreed upon by the Owner and Engineer.

Acceptance of the finished product will be based on:

1. Acceptable in-place density gauge readings at each test location will be between 95% and 105% of the PTD determined during the construction of the Test Panel. If the Test Panel requirement is waived, acceptable in-place densities of the pavement will be as determined by the density gauge operator and the Engineer.
2. A visual evaluation of the pavement surface. The Engineer shall visually compare the pavement surface of the completed section to the Test Panel or other similar successful projects.
3. Porosity Test. Once the top course asphalt has cooled to 80 °F on the surface, the porosity test can be performed at any time after reaching that temperature. Perform a porosity test at 3 locations chosen by the Engineer. At each location, test the porosity for a minimum of 3 minutes. The test is accomplished by applying clean water at a measured rate of at least 20 gal/min at a height of 18" above the surface using a hose or other distribution device. Water used for the test shall be clean, free from suspended solids and deleterious materials and will be provided at no additional cost. All applied water shall infiltrate the test panel directly, without puddle formation or surface runoff, and shall be observed by the Engineer. Water should not travel outside of an area greater than 4 square feet during the test.

Test Panel(s). (If required) A minimum of 1000 sq. ft. test panel will be required to be constructed. The test panel will be constructed at a location designated by the Engineer or as directed in the contract documents, and will remain in place for the duration of the project to be used as a visual reference for acceptance of the pavement surface. Produce, deliver, and construct the test panel in accordance with this specification and the thicknesses specified in the contract documents. The final in-place air voids of each pavement layer shall be 16% to 20% for Top Course and 20 to 25% for Binder / Base Course.

Test Panel Evaluation. The following will be performed on each Test Panel (if required):

1. The owner will provide a density gauge operator that possesses a current Density Gauge Inspector Certification. The density gauge operator will monitor the in-place density of the pavement course.
2. The owner will cut a minimum of three, 6 inch diameter, cores from the finished courses. These cores will be used to determine: The in-place air void of the asphalt course, a density gauge correction factor, and will be used to determine a PTD for use during the paving of the routine paving courses. The final in-place air voids of each pavement layer shall be 16% to 20% for Top Course and 20 to 25% for Binder / Base Course. The PTD will be determined as 81% of the Mixtures Maximum Theoretical Density (MMTD) plus/minus a density gauge correction factor and compacted thickness of the asphalt course.
3. Porosity Test. Once the top course asphalt has cooled to 80 °F on the surface, the porosity test can be performed at any time after reaching that temperature. Perform a porosity test at 3 locations chosen by the Engineer. At each location, test the porosity for a minimum of 3 minutes. The test is accomplished by applying clean water at a measured rate of at least 20 gal/min at a height of 18" above the surface using a hose or other distribution device. Water used for the test shall be clean, free from suspended solids and deleterious materials and will be provided at no additional cost. All applied water shall infiltrate the test panel directly, without puddle formation or surface runoff, and shall be observed by the Engineer. Water should not travel outside of an area greater than 4 square feet during the test.

METHOD OF MEASUREMENT:

This work will be measured as the number of tons of compacted porous asphalt pavement satisfactorily furnished and installed in accordance with the plans, specifications, and orders of the Engineer.

Production meeting the specification requirements will be paid at the bid price. Production failing to meet the specification requirements will be subject to evaluation by the Engineer and Owner.

PART 3 – REFERENCE

A. All work relating to the proceeding specifications, unless otherwise noted, shall be accomplished in accordance with the State of Vermont Agency of Transportation "Standard Specifications for Construction", dated 2018 and applicable State and Federal Laws.

END OF SECTION

SECTION 321400

UNIT PAVING

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. Concrete pavers set in aggregate setting bed.
2. Aluminum edge restraints.
3. Cast-in-place concrete edge restraints.

B. Related Requirements:
1. Section 321313 "Concrete Paving" for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For materials other than water and aggregates.

B. Product Data: For the following:

1. Pavers.
2. Edge restraints.

C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.

D. Samples for Initial Selection: For each type of unit paver indicated and the following:

1. Joint materials involving color selection.
2. Exposed edge restraints involving color selection.

E. Samples for Verification: For full-size units of each type of unit paver indicated. Include Samples of the following:

1. Joint materials.

2. Exposed edge restraints.
3. Concrete pavers

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C 67.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An installer who is certified by the Interlocking Concrete Pavement Institute (ICPI) as either a Level II Installer for Impervious Concrete Pavers or a PICP Installer for Permeable Pavement

B. Mockups: Build 5’x5’ mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.8 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 CONCRETE PAVERS

A. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936/C 936M and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.

1. Uniloc Promenade paver
2. Thickness: 3-15/16”
3. Face Size and Shape: 23-5/8”x 7-7/8” rectangle.
4. Color: tbd
5. Finish: Umbriano
6. Pattern: Running Bond

2.3 CURBS AND EDGE RESTRAINTS

A. Aluminum Edge Restraints: Permaloc Manufacturer’s standard L-shaped Asphalt Edge, 1/8-inch- (3.2-mm-) thick by 3” (76.2mm) x 3” 76.2mm) extruded-aluminum edging with loops pressed from face to receive stakes at 12 inches (300 mm) o.c. and aluminum stakes 12 inches (300 mm) long for each loop.

B. Job-Built Concrete Edge Restraints: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi (20 MPa).

2.4 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 57 subbase material.

B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with complying with ASTM D 448 for Size No. 2 base material.

C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 or CSA A23.1 for fine aggregate.

D. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone complying with ASTM C144 / C33 or CSA 23.1 FA1 / CSA A179.

1. Provide sand of color needed to produce required joint color.

E. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
3. Permittivity: 0.02 per second, minimum; ASTM D 4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.

F. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.

G. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected and waterproofing protection is in place.

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after

deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Joint Pattern: As indicated on drawings.

E. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

1. Provide joint filler at waterproofing that is turned up on vertical surfaces [unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete].

F. Tolerances: Do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving.

G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.
3. Install job-built concrete edge restraints to comply with requirements in Section 033000 "Cast-in-Place Concrete."

3.4 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least 98 percent of ASTM D 698 laboratory density. Submit testing results as specified under Submittals.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Remove organic material, roots, debris or rocks. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Landscape Architect, and replace with compacted backfill or fill as directed.

C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
   1. Turn edges of fabric up along the sides of the opening, covering the sides of the base layer.
   2. There shall be no wrinkles in the fabric on the bottom.
   3. When aggregate is placed on the fabric, the tries from trucks shall be kept off the fabric to prevent wrinkling.

D. Place aggregate subbase base in no more than 4" lifts for pedestrian applications and ¾" lifts for vehicular applications , compact by tamping with plate vibrator, and screed to depth indicated.

E. Place aggregate base, compact to minimum 98 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated. Density measurements of the compacted base shall be made with a nuclear density guage.

F. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).

G. Place leveling sand course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.

H. Treat leveling course with herbicide to inhibit growth of grass and weeds.

I. Set pavers with a minimum joint width of 1/16 inch (1.5 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.

   1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

   1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
   2. Before ending each day's work, compact installed concrete pavers except for 36-inch (900-mm) width of uncompacted pavers adjacent to temporary edges (laying faces).
   3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.
   4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.

K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

L. Do not allow traffic on installed pavers until sand has been vibrated into joints.

M. Repeat joint-filling process 30 days later.

3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION

SECTION 321600
PORTLAND CEMENT SITE CONCRETE

Part 1 - GENERAL

1.0 SUMMARY:

A. The Contractor shall construct the cast-in-place sidewalks, plazas, and trash pads to the dimensions, and at the locations, shown on the contract drawings.

1.1 SCOPE OF WORK:

A. Furnish all labor, materials, equipment and incidentals required to construct or restore sidewalks.

B. In cases where part of an existing walk has been damaged by the Contractor, the entire width of the walk shall be removed and replaced as specified below. Patch work will not be accepted.

1.2 REFERENCE:

A. Section 32 0500 Gravel and Aggregate Base Courses

B. All work related to the preceding specifications, unless otherwise noted, shall be accomplished in accordance with the State of Vermont Agency of Transportation “Standard Specifications for Construction”, dated 2018 and applicable State and Federal laws.

Part 2 - PRODUCTS

2.0 GENERAL:

A. Refer to Section 320500 Gravel and Aggregate Base Courses for preparation of subbase prior to beginning concrete forming and placement.

2.1 PORTLAND CEMENT CONCRETE PAVEMENT:

A. Aggregates for concrete as outlined in State of Vermont Agency of Transportation “Standard Specifications for Construction”, dated 2018, Sections 704.01 and 704.02.

B. Portland Cement for concrete as outlined in State of Vermont Agency of Transportation “Standard Specifications for Construction”, dated 2018, Section 701.

C. Preformed fibre expansion joint filler shall be:

1. Fibre Expansion Joint Filler composed of cellular fibers securely bonded together and uniformly saturated with asphalt so that when the material is compressed to half of its original thickness it will recover to 70% of its original thickness. Joint filler material shall conform to the requirements of ASTM D 1751.

Part 3 - EXECUTION

3.0 GENERAL:

A. The subgrade shall be properly shaped and thoroughly compacted. The subbase of approved gravel, placed to a minimum depth as shown on detail, shall be rolled with a two-axle roller at minimum 5 ton weight.

B. Prior to a concrete being opened for general use, the space on each side of the walk or pad shall be backfilled to the required elevation with suitable material, firmly compacted and neatly graded, then topsoiled, seeded and mulched.

3.1 PORTLAND CEMENT CONCRETE PAVEMENT:

A. Concrete Mix Design: Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, complementary cementitious materials, and admixtures; and applicable reference specifications. Submit cement source, complementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. If source material changes, resubmit mix proportion data using revised source material. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes.

B. Forms: Approved forms shall be of wood or metal and shall extend for the full depth of the concrete. All forms shall be straight or curved as required, free from warp, of sufficient strength to resist the pressure of the concrete without springing and shall be cleaned and oiled before installing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

C. Reinforcing:

1. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M with ASTM A 615/A 615M, Grade 60 bars

2. Galvanized Steel Welded Wire Reinforcing: ASTM A 1064/A 1064M fabricated from galvanized steel wire into flat sheets.

3. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M with ASTM A 615/A 615M with Grade 60 plain steel bars.

D. Cementitious Material:

1. Portland Cement: ASTM C 150/C 150M Portland Cement shall conform to VAOT 701.02. Portland Cement shall be included on the current Vermont Agency of Transportation Approved Cement Suppliers list

2. Fly Ash: ASTM C 618 Type F and shall be included on the current Vermont Agency of Transportation Approved Cement Suppliers List

3. Admixtures: All admixtures shall be included on the current Vermont Agency of Transportation Approved Products List.

E. Concrete Mix:

1. Class A 4,000 psi (28 day compressive strength) (where specified on the plans) - Min. cement content 660 lbs/cy Maximum water-cement ratio – 0.44. Entrained air content 5-7%.

2. 5,000 psi (28 day compressive strength) (where specified on the plans) - Min. cement content 705 lbs/cy Maximum water-cement ratio – 0.44. Entrained air content 5-7%.

F. Finishing:

1. The surface shall be finished with a wooden float. No plastering will be permitted. Before the concrete has taken its set, it shall be tested for waves or irregularities, with a straightedge 10 feet long and any unevenness of ¼ inch or more, either above or below the general contour of the surface shall be immediately remedied.

2. The surface of the concrete, after the floating and screening process is completed, shall be finished with one of the following options.

   a. Type I Concrete Finish (Typical unless otherwise noted)

      1) "Broom Finish" - Broom finish concrete, trowel joints.

3. Provide a Sample Panel for review by the Owner or Owner's Representative. Formed construction, score joints and broom finish shall be straight, concrete surface shall be without irregularities (not wavy, no protruding stones, etc.) Once approved, each concrete pour shall the representative of the Sample Panel.

G. Joints:

1. Unless otherwise indicated on the plans or directed by the Engineer, expansion joints shall be placed every 20 feet. If Contractor proposes to deviate from design plans they shall provide shop drawing with expansion joints and score pattern for approval.

2. Expansion joints shall be formed around all appurtenances such as manholes, utility poles and other obstructions extending into and through the sidewalk. Preformed fiber expansion joint filler (1/2 inch thick) shall be installed in these joints. Expansion joint filler of the thickness indicated shall be installed between concrete sidewalks and fixed structures such as building, stairs, curbs, slabs, etc. This expansion joint material shall extend for the full depth of the walk.

3. Between the expansions joints, the sidewalk shall be divided at intervals equal to the width of the walk or as shown on the plans. Concrete score joints shall be made by a concrete jointing saw or joint tool to provide grooves approximately 1/8 inch wide and at least 1½" of depth. Refer to details for specific requirements regarding tool versus sawcut joint type.

4. When the sidewalk is constructed next to a concrete or granite curb, joint filler shall be placed between sidewalk and curb for the depth of the sidewalk.

H. Curing: Concrete sidewalks shall be cured using the cure and seal product, SpecChem Cure Shield EX in accordance with the manufacturer's specifications.

I. Cold Weather Construction Procedures:

1. It shall be the Contractor’s responsibility to continuously protect soils, concrete, masonry and other building materials from damage due to cold temperatures until the slab has been turned over to the owner.

2. This shall include temporary enclosures, insulated blankets and temporary heating. It shall be the contractor's responsibility to repair and/or replace any damaged or defective work, in a manner approved by the architect/engineer.

3. All protective and corrective work shall be at the expense of the contractor.

END OF SECTION

SECTION 329113

SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

B. Related Requirements:

1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.

1.2 DEFINITIONS

A. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

B. Imported Soil: Soil that is transported to Project site for use.

C. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

F. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

H. USCC: U.S. Composting Council.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.

C. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1. Laboratories: Subject to compliance with requirements, provide testing by one of the following:

a. Connecticut: Soil Nutrient Analysis Laboratory, University of Connecticut

b. Maine: Maine Soil Testing Service, University of Maine

c. Massachusetts/Rhode Island: Soil & Plant Tissue Testing Laboratory, University of Massachusetts

d. New Hampshire: UNH Cooperative Extension Soil Testing, University of New Hampshire

e. New York/Vermont: Cornell Nutrient Analysis Laboratories, Cornell University

f. Pennsylvania: Ag. Analytical Ser. Laboratory, Pennsylvania State University

g. Vermont: Agricultural and Environmental Testing Lab, University of Vermont

h. If state is not listed above, contact cooperative extension office in project's state. Discuss with Landscape Architect prior to submission.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.

1. Notify Landscape Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

C. Additional Project Soil Testing: Provide Landscape Architect with copy of any existing soil tests, including foundation borings for reference and review by Landscape Architect.

1.8 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Landscape Architect, under the direction of the testing agency.

1. Number and Location of Samples: Follow direction of testing agency for quantity and location of samples for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples:
   a. Follow directions from testing agency for recommended sample-collection method.
   b. Or according to: According to USDA-NRCS's "Field Book for Describing and Sampling Soils (available online)
3. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.9 TESTING REQUIREMENTS: EXISTING ON-SITE SURFACE SOIL

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

   a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
   b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

.

2. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.

3. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NEC-67 including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm and sodium absorption ratio.
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Submit results of soil test for review by landscape architect. As approved by landscape architect, follow recommendations for each plant-type as listed in plans.

1.10 TESTING REQUIREMENTS: IMPORTED, NATURALLY FORMED SOIL

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
b. Hydrometer Method: Report percentages of sand, silt, and clay.

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

2. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium,

and vanadium. If RCRA metals are present, include recommendations for corrective action.

3. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NEC-67 including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Macronutrients
6. Micronutrients
7. Soluble-salts ppm.
8. Presence and quantities of problem materials including salts and metals. If such problem materials are present, provide additional recommendations for corrective action.
9. Other deleterious materials, including their characteristics and content of each.

E. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Submit results of soil test for review by landscape architect. As approved by landscape architect, follow recommendations for each plant-type as listed in plans.

1.11 COMPOST TESTING

A. General: Perform tests according to USCC Seal of Testing (STA) Program:

B. Analysis to include, but not limited to:
1. pH
2. Soluble Salt Concentration (electrical conductivity)
3. Nutrient Content
4. Moisture Content
5. Organic Matter Content
6. Particle Size
7. Trace Elements/Heavy Metals (meet US EPA Part 503 Regulations)

1.12 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Regional Materials: Acquire imported soil and soil amendments and fertilizers within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

2.2 PLANTING SOILS SPECIFIED BY COMPOSITION

A. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

B. Planting-Soil Type: Imported, naturally formed soil from off-site sources and consisting of sandy loam according to USDA textures; and modified to produce viable planting soil.

1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep, not from agricultural land**,** bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.

2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6 to 7 and 5 – 7 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
3. Unacceptable Properties: Clean soil of the following:

    a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
    c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches (50 mm) in any dimension.

4. Amended Soil Composition: Blend imported, unamended soil with soil amendments and fertilizers in quantities as recommended by soil test agency to produce planting soil.

2.3 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through a No. 60 (0.25-mm) sieve.
2. Form: Provide lime in form of ground dolomitic limestone, calcitic limestone, or mollusk shells per soil test recommendations. *Note: using dolomitic lime is preferred when both pH and magnesium adjustments are needed; Calctic lime is most appropriate when levels of magnesium are already sufficient; Mollusk shells are most appropriate when Calctic lime is needed (Soil Testing Handbook for Professionals in Agriculture, Horticulture, Nutrient and Residuals Management, University of Maine, 1997; page 29).*

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 (0.30-mm) sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

2.4 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:

1. Feedstock: Limited to leaves.
2. Reaction: pH of 6.5 to 7.4.
3. Soluble-Salt Concentration: Less than 2.5 dS/m.
4. Moisture Content: 35 to 55 percent by weight.
5. Organic-Matter Content: 30 to 40 percent of dry weight.
6. Particle Size: Minimum of 98 percent passing through a 1-inch (25-mm) sieve.

B. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.5 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; in amounts recommended in soil reports from a qualified testing agency.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

3.2 EXAMINATION OF SUBGRADE

A. The subgrade shall be examined by the Contractor prior to the start of subgrade preparation, soil placement and planting. Any deficiencies shall be noted and relayed to the Landscape architect in writing prior to acceptance of the subgrade by the Landscape Contractor. Deficiencies include, but shall not be limited to:

1. Construction debris present within the planting areas.
2. The subgrade is at incorrect depths for installing the designed soil profile and drainage layer.
3. Incomplete irrigation and/or subsurface drainage installation.
4. Incomplete lighting and exterior electrical installation.
5. Conflict with underground utilities.
6. Subgrade contaminated with oils, compressible material, silt or clay.
7. Subgrade must infiltrate water at the rate of at least one inch per hour.

3.3 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches (150 mm) and stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 2-inch (50-mm) sieve to remove large materials.

3.4 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 8 inches (200 mm). Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Spread unamended soil to total depth as identified by plant type in Section 329300 “Plants”, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.

    a. Mix lime and sulfur, if required, with dry soil before mixing fertilizer.
    b. Mix fertilizer with planting soil no more than seven days before planting.
    c. Mix compost with top 8-12” of planting soil.

2. Lifts: Apply planting soil in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

A. Compaction: Compact each lift of planting soil to 75 percent of maximum Standard Proctor density according to ASTM D698 except where a different compaction value is indicated on Drawings.

B. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 8 inches (200 mm). Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Application: Spread planting soil to total depth as identified by plant type in Section 329300 “Plants”., but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Lifts: Apply planting soil in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each lift of planting soil to 75 percent of maximum Standard Proctor density according to ASTM D698 except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth as identified by plant type in Section 329300 “Plants”. Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.

1. Mix lime and sulfur, if required, with dry soil before mixing fertilizer.
2. Mix fertilizer with planting soil no more than seven days before planting.

3. Mix compost with top 8-12” of planting soil.

D. Compaction: Compact blended planting soil to 75 percent of maximum Standard Proctor density according to ASTM D698 except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.7 PROTECTION AND CLEANING

A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."

B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

C. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION

SECTION 329200

TURF AND GRASSES

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. Lawn hydroseeding.
   2. Meadow grasses seeding.
   3. For Wetland seeding see civil drawings.

B. Related Requirements:

   1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and meadow establishment.

1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: May 1 – June 30.
2. Fall Planting: September 1 – November 1.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Grass-Seed Mix: Proprietary seed mix as follows:

1. Products: Subject to compliance with requirements, provide the following:

a. Catamount Seed Mix: Green Mountain Special; LD Oliver Seed Company; 26 Sunset Ave., Milton, VT 05468.

2.2 MEADOW GRASSES / CONSERVATION MIX

A. Meadow / Conservation Mix: Proprietary seed mix as follows:

1. Products: Subject to compliance with requirements, provide the following:

a. Catamount Seed Mix: Conservation Mix; LD Oliver Seed Company; 26 Sunset Ave., Milton, VT 05468.

B. Seed Carrier: Inert material, sharp clean sand or perlite.

2.3 FERTILIZERS

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition:

a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

E. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.5 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils,

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gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.4 HYDROSEEDING

A. Hydroseeding: Mix specified seed, slow-release fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.

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2. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre (5.2-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of [1000 lb/acre (10.4 kg/92.9 sq. m).

3.5 TURF RENOVATION

A. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

C. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

D. Mow, dethatch, core aerate, and rake existing turf.

E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).

H. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches (100 mm) of existing soil. Install new planting soil to fill low spots and meet finish grades.

1. Soil Amendment(s): according to requirements of [Section 329113 "Soil Preparation.".
2. Initial Fertilizer: Slow-release fertilizer applied according to manufacturer's recommendations.

I. Apply seed and protect with straw mulch as required for new turf.

J. Water newly planted areas and keep moist until new turf is established.

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3.6 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow lawn to a height of 2 to 3 inches (50 to 75 mm).

D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to turf area.

3.7 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).

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B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.8 MEADOW

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).

1. Before sowing, mix seed with seed carrier at a ratio of not less than three parts seed carrier to one part seed.
2. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
3. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at a total rate of 5lbs. per 1,000 SF.

C. Brush seed into top 1/16 inch (1.6 mm) of soil, roll lightly, and water with fine spray.

D. Protect seeded areas from hot, dry weather or drying winds by applying peat or compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.

E. Water newly planted areas and keep moist until meadow is established.

3.9 MEADOW MAINTENANCE

A. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water meadow with fine spray at a minimum rate of 1/2 inch (13 mm) per week for eight weeks after planting unless rainfall precipitation is adequate.

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C. Mowing: Mow in fall to height of 4 to 6 inches (100 to 150 mm).

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.12 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Seeded Turf: 60 days from date of Substantial Completion.

    a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

B. Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Meadow Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than maintenance period below.

1. Maintenance Period: 40 days from date of Substantial Completion.

END OF SECTION

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SECTION 329300

PLANTING

PART ONE - 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 planting in road right-of-way and at grade against parking garage structure including:
   1. Trees.
   2. Shrubs.
   3. Ornamental Grasses.
   4. Landscape edgings.

B. Related Requirements:

   1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

G. Finish Grade: Elevation of finished surface of planting soil.

H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

I. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Plant Product Data: For each type of plant specified:

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
2. Plant Photographs: Include color photographs in digital 3- by 5-inch (76- by 127-mm) print format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Supplemental Product Data: For each type of product specified.

C. Samples for Verification: For each of the following:
1. Compost Mulch: 1-pint (0.5-L) volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
2. Mineral Mulch: 2 lb (1.0 kg) of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material

to be delivered and installed on-site; provide an accurate indication of color, texture, and makeup of the material.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.

E. Substitutions: Notify Landscape Architect immediately if any plant material is unavailable, but at a minimum 10 days prior to installation. Substitutions may only be made if reviewed and approved by Landscape Architect.

F. Unavailability of Plant Materials: Before changes or substitutions can be made due to unavailability of plant material, submit satisfactory evidence that the Contractor has advertised for a one month period in a trade journal such as the “Landscape Materials Information Service,” with no response, or has undertaken other methods of locating plant material acceptable to the Landscape Architect.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Handle planting stock by root ball.

F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.

G. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

H. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

I. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: After ground has thawed through July 15
2. Fall Planting: September 1 through October 31st.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

D. Variance: If special conditions exist that warrant a variance in the above planting dates, a written request shall be submitted to the Landscape Architect stating the special conditions and the proposed variance. Permission for the variance will be given if warranted in the opinion of the Landscape Architect. Any variance in the planting season will not affect the guarantee period. Planting season may be extended only with the written permission of the Landscape Architect.

1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
b. Structural failures including plantings falling or blowing over.
c. Faulty performance of edgings and tree grates.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Substantial Completion

a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
c. Annuals: Three months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease,

pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 WATER

A. General: Water shall be suitable for irrigation and shall be free from ingredients harmful to plant life.

B. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
1. Size and nutrient composition to be determined by results of soil test, see Section 329300 “Soil Preparation”.

2.3 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood
2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.

3. Color: Natural.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch (25-mm) sieve; soluble-salt content of less than 2.5dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

C. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:

1. Type: Rounded riverbed gravel or smooth-faced stone
2. Size Range: 3/4 inch (19 mm) maximum, 1/4 inch (6.4 mm) minimum.
3. Color: Uniform tan-beige color range acceptable to Landscape Architect.

2.4 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 ACCESSORIES

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb (0.45 kg) of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb

(0.45 kg) of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

C. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Border Concepts, “Border Guard” Steel Edging, Finish: Unfinished

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: At time directed by Landscape Architect, broadcast dry product uniformly over prepared soil at application rate as specified by soil test agency according to manufacturer's written recommendations.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.
3. For bare-root stock excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots.
4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated by soil test results or other means.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.

D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Percolation Test: Test drainage of five plant beds and pits chosen by the Landscape Architect shall be done with water twice in succession. The time at which the water is put into the pit or bed for a second filling shall be noted. The Landscape Architect shall then be notified of the time it takes for pit or bed to drain completely. Planting operations shall not proceed until the Landscape Architect has reviewed the drainage test results.
1. Notify the landscape architect in writing of all soil or drainage conditions which are considered detrimental to growth of plant material. Submit proposal and cost estimate for the correction of the conditions for Landscape Architect’s approval before starting work.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Backfill: Planting soil. For trees, use excavated soil for backfill.

2. After placing some backfill around root ball to stabilize plant, carefully cut and remove all burlap, rope, and wire baskets from tops of root balls and from sides. Remove wire basket from at least one third of the top of the root ball after root ball has been stabilized. If complete removal of burlap would severely disrupt the root ball, the burlap should be pulled down so it is below the upper third of the ball. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation. No burlap shall emerge from the soil or be near the soil surface after the hole is backfilled.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. If required by results of soil test (see Section 329300 “Soil Preparation”) place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.

    a. Quantity: As determined by results of soil test and manufacturer’s recommendations; see Section 329300 “Soil Preparation”.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Balled and Potted and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Backfill: Planting soil; For trees, use excavated soil for backfill.
2. Carefully remove root ball from container without damaging root ball or plant.
3. If the plant is pot bound, carefully make four 1” slices with a knife, spade or trowel down the sides of the pot and also slice the bottom of the root ball. Tease out roots as needed.
4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.

    a. Quantity: As determined by results of soil test and manufacturer’s recommendations; see Section 329300 “Soil Preparation”.

6. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Fabric Bag-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Backfill: Planting soil; For trees, use excavated soil for backfill.
2. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. If the plant is pot bound, carefully make four 1” slices with a knife, spade or trowel down the sides of the pot and also slice the bottom of the root ball. Tease out roots as needed.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grade.

1. Backfill: Planting soil; For trees, use excavated soil for backfill.
2. Spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working.
3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside soil-covered roots about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole or touching the roots.

    a. Quantity: As determined by results of soil test and manufacturer’s recommendations; see Section 329300 “Soil Preparation”.

6. Continue backfilling process. Water again after placing and tamping final layer of soil.

G. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE-SPADE PLANTING

A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.

C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

D. Cut exposed roots cleanly during transplanting operations.

E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Landscape Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than 14 feet (4.2 m) in height and more than 3 inches (75 mm) in caliper unless otherwise indicated.

1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

    a. Securely attach guys to stakes 30 inches (760 mm) long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide turnbuckle for each guy wire and tighten securely.
    b. For trees more than 6 inches (150 mm) in caliper, anchor guys to wood deadmen buried at least 36 inches (900 mm) below grade. Provide turnbuckle for each guy wire and tighten securely.
    c. Support trees with guy cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
    d. Attach flags to each guy wire, 30 inches (760 mm) above finish grade.

2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.9 PERENNIAL, ORNAMENTAL GRASS, GROUND COVER AND BULB PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated in Drawings and Plant Schedule in even rows with triangular spacing.

B. Use planting soil, amended per soil test recommendations for applicable plant types as indicated in Section 329113 Soil Preparation for backfill.

C. Dig holes large enough to allow spreading of roots, 12” minimum depth, and scarify sides of hole.

D. If the plant is pot bound, carefully make four 1” slices with a knife, spade or trowel down the sides of the pot and also slice the bottom of the root ball. Tease out roots as needed.

E. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

F. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

G. Apply slow-release fertilizer evenly, in amounts as required by soil test results and according to manufacturer's recommendations. Do not allow fertilizer direct contact with plant roots, stems, or leaves.

H. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

I. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.10 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.
   1. Organic Mulch in Planting Areas: Apply 2-inch (50-mm) to 3-inch (75-mm) average thickness of organic mulch extending 12 inches (300 mm) beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) to 6 inches (150 mm) of trunks or stems.

3.11 EDGING INSTALLATION

A. Aluminum Edging: Install aluminum edging where indicated according to manufacturer's written instructions. Anchor with aluminum stakes spaced approximately 36 inches (900 mm) 48 inches (1200 mm) apart, driven below top elevation of edging.

B. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch- (100- to 150-mm-) deep, shovel-cut edge.

3.12 TREE GRATE INSTALLATION

A. Tree Grates: Install according to manufacturer's written instructions. Set grate segments flush with adjoining surfaces. Shim from supporting substrate with soil-resistant plastic. Maintain a 3-inch- (75-mm-) minimum growth radius around base of tree; break away portions of casting, if necessary, according to manufacturer's written instructions.

3.13 INSTALLING SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.14 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.15 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.16 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Landscape Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.

B. Remove and replace existing or new trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of 6 inches (150 mm) or smaller in caliper size.
2. Provide two new tree(s) of 4-inch (100-mm) caliper size for each tree being replaced that measure more than 6 inches (150 mm) in caliper size.
3. Species of Replacement Trees: Species selected by Landscape Architect.

3.17 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.18 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Substantial Completion.

END OF SECTION

TRANSPLANTING

SECTION 329600

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes transplanting rare and endangered Prunus americana found on site. Moving fifteen (15) clumps from the clone and transplant them to a protected area at the northern edge of the parcel.

1.2 DEFINITIONS

A. General: See definitions in ANSI A300 (Part 6) and in ANSI Z60.1 pertaining to field-grown trees, except as otherwise defined in this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Maintenance Recommendations: From arborist, recommended procedures to be established by Owner for care and protection of trees after completing the Work.

B. Existing Conditions: Documentation of existing trees indicated to be transplanted, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1.5 QUALITY ASSURANCE

A. Tree-Service Firm Qualifications: An experienced landscaping contractor or tree-moving firm that has successfully completed transplanting work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

1. Arborist Qualifications: Certified Arborist as certified by ISA, licensed arborist in jurisdiction where Project is located, current member of ASCA, or registered Consulting Arborist as designated by ASCA.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy their natural shape.

B. Completely cover foliage when transporting trees while they are in foliage.

C. Handle trees by root ball. Do not drop trees.

D. Move trees after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after moving, set trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify final grade elevations and final locations of trees and construction contiguous with trees by field measurements before proceeding with transplanting work. Perform transplanting only after finish grades are established.

B. Seasonal Restrictions: Transplant trees during the following in-season periods:
1. Fall: Mid to late September.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Provide tree maintenance by skilled employees of tree-service firm and as required in Part 3. Begin maintenance immediately after trees are installed and continue until plantings are healthy and well established but for not less than maintenance period below.

1. Maintenance Period: 18 months from date of transplanting completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Transplanted trees shall be healthy and resume vigorous growth within one year of transplanting without dieback due to defective extracting, handling, planting, maintenance, or other defects in the Work.

2.2 PLANTING MATERIALS

A. Backfill Soil: Excavated soil mixed with planting soil of suitable moisture content and granular texture for placing and compacting in planting pit around tree, and free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry,

concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.

1. Planting Soil: Planting soil as specified in Section 329113 "Soil Preparation."

2.3 WATERING DEVICES

A. Watering Pipe: PVC pipe 4 inches (100 mm) in diameter, site-cut to length as required, and with snug-fitting removable cap.

B. Slow-Release Watering Device: Standard product manufactured for drip-irrigation of plants and emptying its water contents over a period of 2 to 9 hours; manufactured from UV-light stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

2.4 MISCELLANEOUS PRODUCTS

A. Organic Mulch: Wood and bark chips as specified in Section 329300 "Plants."

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

C. Burlap: Non-synthetic, biodegradable.

D. Pesticides: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

E. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 5-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

PART 3 - EXECUTION

3.1 PREPARATION

A. A Prior to transplanting, in mid- to late September, fruit (if any) will be collected and the seeds extracted. These seeds will be given to the Vermont Wildlife Diversity Program to be forwarded to the Native Plant Trust of the New England Wildflower Society for propagation. This work will be performed by Gilman & Briggs.

B. In spring 2023, cuttings will be taken by Gilman & Briggs and transferred, through the Vermont Wildlife Diversity Program, to the Native Plant Trust for propagation. If

successful, rooted cuttings will be used on the project site (if transplanting is not successful) or be made available for planting at sites chosen by the Vermont Wildlife Diversity Program.

C. In the fall of 2023 when seasonal growth has ceased, sections of the clone will be identified and marked (using plastic flagging) for transplanting by Gilman & Briggs. These sections will measure 3 feet x 3 feet and include stems 1 to 2 inches in diameter along with younger new growth. Any invasive shrubs (buckthorn, honeysuckle, etc.) present will be identified and removed.

D. Using a front-end loader or similar equipment, receiving sites will be prepared in the proposed transplantation site.

E. Using the same equipment, the previously selected sections of the plant will be lifted and moved to the prepared receiving sites. The transplanted material will be firmed in and watered and mulched with wood chips.

F. Demark the transplantation site by a line of fence posts or other similar material to indicate areas not to be mown in the normal maintenance of the designated open space area.

G. Transplant as much material as possible to the transplantation area in a manner that would encourage their survival

3.2 MULCHING

A. Organic Mulch: Apply 2-inch (50-mm) average thickness of organic mulch.

3.3 INSTALLING SLOW-RELEASE WATERING DEVICE

A. Place device on top of the mulch at base of tree and fill with water according to manufacturer's written instructions.

3.4 TREE MAINTENANCE

A. Perform tree maintenance as recommended by arborist. Maintain arborist observation of transplanting work.

B. Maintain trees by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Treat as required to keep trees free of insects and disease.

C. From time of tree extraction measure soil moisture adjacent to edge of each root ball weekly. Record findings and weather conditions.

D. Fill areas of soil subsidence with backfill soil. Replenish mulch materials damaged or lost in areas of subsidence.

E. Apply treatments as required to keep tree materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

F. Pesticide Application: Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.5 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Except for materials indicated to be recycled, remove surplus soil, excess excavated material, waste materials, displaced plants, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 330516

UTILITY STRUCTURES – STORM MANHOLES

PART 1 - GENERAL

1.0 SUMMARY:

A. The Contractor shall construct reinforced concrete manholes and drop manholes to the dimensions at the locations shown on the contract drawings. All precast reinforced concrete manhole sections shall conform to the latest version of the ASTM Specifications C478. The exterior of the manhole shall be coated with a waterproof sealant.

PART 2 - PRODUCTS

2.0 GENERAL:

A. The footing shall be Class A precast concrete and shall conform to the dimensions indicated on the plans.

B. All construction of storm manholes must be carried out to ensure watertight work. Any leaks in manholes shall be caulked and completely repaired to the satisfaction of the Engineer or the entire structure shall be removed and rebuilt. Repairs shall only be allowed to the exterior of the manhole.

C. All manholes shall be provided with heavy duty, gray, cast iron manhole frames and covers or grates. All iron castings shall be thoroughly cleaned and then coated with hot tar before being delivered. Frames and solid covers shall be 6” high (min.), round, heavy duty cast iron with 24” minimum clear opening and able to support h20 wheel load capacity. Manhole covers shall have the word STORM printed on them. Catch basin frames and grates shall be 6” high (min.), heavy duty cast iron with 24” square minimum clear openings and able to support h20 wheel load capacity.

D. Precast risers and bases for manholes shall conform to ASTM Specifications C-478. The pipe opening in the precast manhole riser shall have a cast-in-place flexible gasket, mastic, or an equivalent system for pipe installation as approved by the Engineer. Joints between manhole risers shall be rubber “O” ring seals or soft Butyl joint sealer (rope form).

E. The manhole cover frames shall be set to final grade only after the base course paving has been completed. Manholes shall be constructed to grade with precast or cast-in-place concrete risers (4,000 psi minimum). All manhole lift holes shall be grouted inside and out with expandable grout.

F. Catch basin shall have the Owner supplied “Stormwater – No Dumping” discs secured to the grate.

PART 3 - EXECUTION

3.0 GENERAL:

A. See plans and details.

PART 4 - REFERENCE

A. All work relating to these specifications, unless otherwise noted, shall be accomplished in accordance with the State of Vermont Agency of Transportation “Standard Specifications for Construction”, dated 2018 and applicable State and Federal laws.

END OF SECTION

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SECTION 331116

WATER SYSTEMS

PART 1 - GENERAL

1.0 DESCRIPTION:

A. Work Included: Furnish all labor, materials, equipment and incidentals necessary to completely install all water systems as specified herein, as shown on drawings or as directed by Engineer. All testing shall be at the Contractor's expense.

1.1 SUBMITTALS:

A. Manufacturer's information relative to installation shall be submitted with catalog cuts.

B. Results of pressure leak testing showing line has conformed with pressure/leak testing specifications.

C. Results of two bacteriological examinations showing coliform bacteria absent.

D. Results of compaction tests at 100-foot intervals along the line showing trench compaction conforms with the specifications.

PART 2 - PRODUCTS

2.0 The pipe and fittings shall be Class 52 ductile iron manufactured in accordance with AWWA C110, C111 and C509. See specifications on plans.

2.1 FITTINGS: Ductile iron fittings shall conform to applicable provisions within AWWA C110 and C153, and ANSI Specification A21.10, 350 pounds working pressure, and be of a compact body design. Ductile iron fittings larger than sixteen inches (16") shall have a standard body length equal to Class 250 cast iron fittings and conform to AWWA C110. Cast iron Class 250 fittings will be allowed in lieu of ductile iron fittings in sizes larger than sixteen inches (16").

2.2 GATE VALVE RESILIENT SEAT: Valves shall be manufactured to meet all requirements of AWWA Specifications C509. Valves sixteen inches (16") and smaller shall be bubble-tight, zero leakage at 200 psi working pressure. Valves shall have non-rising stems, open clockwise, and be provided with a two-inch (2") square operating nut with arrow cast in metal to indicate direction of opening.

Each valve shall have maker's name, pressure rating, and year in which manufactured cast on the body. Prior to shipment from the factory, each valve shall be tested by hydrostatic pressure equal to twice the specified working pressure. Buried valves shall be installed with a valve box.

2.3 VALVE BOXES: Cast iron three-piece slide-type; five and one-fourths inch (5 ¼") shaft, six-foot (6') trench depth. Cast iron cover marked "WATER" and indicating direction of opening.

2.4 FIRE HYDRANTS: Fire hydrants shall be American Darling B-62-B and shall conform to AWWA C502 with the following specifications: (Contractor to confirm with municipality)

Main Valve Opening:	5 ¼ inches
Operating Nut:	Two 2 ½ inch hose nozzles with National Standard thread. One 4 ½ inch pumper nozzle with national standard thread.
Inlet Connection:	6-inch mechanical joint
Operating Nut:	Standard ½ inch pentagon
Direction of Opening:	Clockwise
Color:	Enameled hydrant red
Depth of Bury:	Hydrant shall be installed to the manufacturer's instructions with nozzles 24" (+/- 2") above finish grade.

* - All hydrants shall be 4' – 6' from the edge of pavement.

2.5 TAPPING SLEEVES: For Existing Ductile Iron Pipe

A. Tapping sleeves shall be of the split-sleeve design constructed with two solid half-sleeves bolted together. Sleeves shall be constructed of cast iron or fabricated steel and shall have a working pressure of 150 psi. Cast iron sleeves shall have mechanical joint ends with side gasket seals. Fabricated steel sleeves shall have end and side gasket seals, and all exterior – exposed surfaces shall be fusion-bonded epoxy-coated to a minimum of 10-mil thickness. Where the branch outlet is not greater than 50 percent of the main size, an "O" ring seal is acceptable with fabricated steel sleeves.

2.6 IDENTIFICATION:

A. Each pipe length and fitting shall be clearly marked with:

1. Manufacturer's name
2. Nominal pipe diameter
3. ASTM designation
4. Class designation

PART 3 - EXECUTION

3.0 GENERAL:

A. The water systems shall be installed to the location shown on the drawings or as directed by the Engineer.

3.1 INSTALLATION:

A. Joints shall be made in accordance with the manufacturer's recommendations.

B. All water system materials shall be free from defects. Materials found to be defective shall be removed from the site. The Contractor is responsible for inspecting all materials to be used prior to installation. Defective material which has been installed shall be removed and replaced with non-defective material at the Contractor's expense.

3.2 LAYING PIPE:

A. Water system materials shall be installed according to AWWA C600, the manufacturer's recommendations and as follows:

1. Excavate the trench bottom as indicated on trench detail.
2. Replace with compacted material as indicated in the excavation and backfill specifications and as shown on the drawings.
3. All fittings shall be wrapped in 3 mil. minimum polyethylene before thrust blocks are poured.
4. Open ends of pipe shall be protected to prevent the entrance of debris.
5. Prior to testing, thoroughly flush the pipe.

3.3 PRESSURE/LEAK TEST:

A. Testing of the water shall consist of the testing of all installed pipe, services, and hydrants in accordance with C600 except as noted. The testing shall consist of a pressure test followed by a leak test. All testing shall be done with potable water and in the presence of the Engineer. The pressure test consists of maintaining an internal pipe pressure of 200 psi (minimum) of working pressure for one hour without dropping more than 5 psi. Failure to hold the pressure within 5 psi for the specified time constitutes a failure of the pressure test. The leakage test shall be conducted for two hours. The time for the pressure test may be included with the time of the leakage test. During the leakage test, the quantity of water necessary to maintain 200 psi (min) shall not exceed the allowable values shown in table 7 AWWA C-600. Failure of any test section will necessitate repair and/or replacement of the failed section at the Contractor's expense. When repairs on a failed section of line are completed, it shall be retested.

3.4 DISINFECTION:

A. Disinfection shall be in accordance with AWWA C-651. The method of disinfection shall be approved by the Engineer. The minimum concentration of chlorine shall be 25 mg/L for 24 hours.

B. After 24 hours, the water main shall be flushed and two bacteriological samples taken to the Vermont Health Department for examination. If two samples indicate no bacteriological contamination, the line may be put into service. If one sample tests positive for bacteria, the Contractor will disinfect, flush and sample the line until it tests negative for bacteria at his own expense. All testing shall be completed in the presence of the Engineer. The Engineer shall be given at least 24 hours notice prior to any testing. The Engineer's representative shall deliver samples to the Vermont Health Department. All bacteriological test kit costs are the responsibility of the Contractor.

END OF SECTION

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SECTION 333100

SEWER PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This item shall consist of the excavation and backfilling required for the complete construction of gravity sewers, force mains, and all appurtenant construction related thereto, including cleanouts, service connections, thrust blocks, and other items necessary for a complete sanitary sewer system as indicated on the drawings. All testing shall be at the Contractor's expense.

1.2 SUBMITTALS

A. Manufacturer's information relative to product compliance with the specifications and installation instructions shall be submitted with the catalog cuts.

B. Results of the leak testing showing the line conforms with the leakage specifications.

C. Results of compaction tests at 100 foot intervals along the line showing trench compaction conforming to the specification.

1.3 REFERENCE

A. All work relating to these specifications, unless otherwise noted, shall be accomplished in accordance with the State of Vermont Agency of Transportation "Standard Specifications for Construction", dated 2018 and applicable State and Federal laws.

PART 2 - PRODUCTS

2.1 TYPES OF PIPE

A. Types of pipe which shall be used for the various parts of work are as follows:
   1. Gravity sewers shall be PVC solid wall pipe meeting ASTM Specifications D-3034 or F679, or an approved equal.
   2. Force mains shall be PVC with push-on joints, PVC SDR21 (Class 200). (Or as indicated on the plans and details.)

2.2 PVC SEWER PIPE

A. PVC sewer pipe shall conform in all respects to the latest revision of ASTM Specifications D-3034 or F679, Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, SDR35. Wall thickness of all PVC shall meet ASTM Specifications for SDR35 pipe. All pipe and fittings shall be clearly marked as follows:
   1. Manufacturer's Name and Trademark
   2. Nominal Pipe Size
   3. Material Designation 12454C PVC
   4. Legend "Type PSM SDR35 PVC Sewer Pipe" or
   5. "PS 45 PVC Sewer Pipe"
   6. Designation ASTM D-3034 or F679

B. Joints shall be push-on type using elastomeric gaskets and shall conform to ASTM D-3212. The gaskets shall be factory installed.

C. The pipe shall be furnished in nominal 13 foot lengths. Sufficient numbers of short lengths and full machine fittings shall be provided for use at manholes, cleanouts, and connections. All connections will require the use of manufactured fittings.

D. Any pipe fittings having a crack or other defect or which has received a severe blow shall be marked rejected and removed at once from the work site. All field cuts are to be made with saw and 90 degree mitre box. Bevel the cut end to the same as the factory bevel and remove all interior burrs.

E. The pipe installed under this specification shall be installed so that the initial deflection shall be less than two percent (2%).

F. The manhole water stop gasket and stainless steel clamp assembly must be approved by the Engineer prior to installation of any pipe.

G. The Contractor will submit certification that the materials of construction have been sampled, tested, and inspected, and that they meet all the requirements – including wall thickness – in accordance with ASTM C-3034 or ASTM F679 for all pipe and fittings to be included in the project work.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavations shall be made to a point at least six inches (6") below the pipe invert to accommodate the bedding material. All excavations are to be kept dry while pipe is being laid and until each joint has been inspected by the Engineer and approval given to commence backfilling operations.

3.2 LAYING SEWER PIPE

A. The bell end of the pipe shall face upgrade at all times and be placed in such a position as to make the invert even when the succeeding section is inserted. Where required by adverse grading conditions, the Contractor shall fill and gully to make a suitable bedding for the sewer pipe. The fill shall be pneumatically compacted to a 95 percent (95%) dry density by the AASHTO-T-99, Method A (Standard Proctor) test, upon which the six inches (6") of bedding material shall be placed.

B. Any pipe which is not laid to grade and alignment shall be re-laid to the satisfaction of the Engineer. The bedding material shall be placed and compacted on each side of the pipe to a height equal to one-half the pipe diameter and for the full width of the excavated trench and as shown on the accepted plans.

3.3 BACKFILL

A. Backfill shall consist of approved material placed in six inch (6") layers with each layer being thoroughly compacted to not less than 95 percent (95%) of maximum dry density as determined by the AASHTO-T-99 Standard Proctor by means approved by the Engineer.

B. No stones in excess of one and one-half inch (1 ½") diameter shall be placed within two feet (2') of the outside of the pipe. Particular precautions shall be taken in placement and compaction of the backfill material in order not to damage and/or break the pipe.

C. The backfill shall be brought up evenly on both sides of the pipe for its full length. Walking or working on the completed pipeline, except as may be necessary in tamping or backfilling, shall not be permitted until the trench has been backfilled to a height of at least two feet (2') on the top of the pipes. During construction, all openings to the pipelines shall be protected from the entering of the earth or other materials.

3.4 CONCRETE CRADLE AND ENCASEMENT FOR PIPE

A. Where required on the plans or as directed by the Engineer, a concrete cradle shall be used to bolster and strengthen pipe. Where required on the plans or as directed by the Engineer, concrete encasement or sewer will be made to protect nearby wells or waterlines for stream crossings or for similar purposes. All concrete will be Class A as defined in the Vermont Standard Specifications for Construction, Section 541, and will meet the requirements of that section.

3.5 FROST PROTECTION FOR SHALLOW SEWERS

A. Sewers with less than five feet (5') of cover over the crown or where indicated on the plans shall be protected against freezing by installation of two inch (2") thick Styrofoam SM insulating sheets with a total width of four feet (4') or twice the pipe diameter, whichever is greater. The sheets shall be placed six inches (6") above the crown of the sewer after compaction of the six-inch (6") lift immediately above the crown. Care shall be exercised by the Contractor during backfill, and compaction over the Styrofoam SM sheets shall meet the compressive strength requirements of ASTM D1621-73 and shall be as manufactured by Owens Corning, or equal. In no case shall

the sewer lines have less than four feet (4') of cover over the top of the pipe. Contact Engineer if any section of sanitary sewer has less than five feet (5') of cover.

3.6 LEAKAGE TESTS AND ALLOWANCES FOR GRAVITY SEWERS

A. The low-pressure air test will be used to simulate infiltration or exfiltration rates into or out of all gravity sewers. The Contractor will furnish all facilities and personnel for conducting test.

B. Final acceptance of the sewer shall depend upon the satisfactory performance of the sewer under test conditions. The test shall be performed on pipe between adjacent manholes after backfilling has been completed and compacted.

C. All wyes, tees, laterals, or end-of-side sewer stubs shall be plugged with flexible-joint caps, or an acceptable alternate, securely fastened to withstand the internal test pressure. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible-jointed lateral connection or extension.

D. Prior to testing for acceptance, the pipe should be cleaned by passing through the pipe a full gauge squeegee. It shall be the responsibility of the Contractor to have the pipe cleaned. Immediately following the pipe cleaning, the pipe installed shall be tested with low-pressure air.

E. Air shall be slowly supplied to the plugged air installation until the internal air pressure reaches four pounds per square inch (4.0 psi) greater than the average backpressure of any groundwater that may submerge the pipe. At least two minutes shall be allowed for temperature stabilization before proceeding further.

F. The pipeline shall be considered acceptable when tested an average pressure of three pounds per square inch (3.0 psi) greater than the average back pressure of any groundwater that may submerge the pipe if:
   1. The total rate of air loss from any section tested in its entirety between manhole and cleanout structures does not exceed 2.0 cubic feet per minute; or
   2. The section under test does not lose air at a rate greater than 0.0030 cubic feet per minute per square foot of internal pipe surface.

G. The requirements of this specification shall be considered satisfied if the time required in seconds for the pressure to decrease from 3.5 or 2.5 psi greater than the average back pressure of any groundwater that may submerge the pipe is not less than that computed according to the following table:

MINIMUM TEST TIME FOR VARIOUS PIPE SIZES

Diameter (inches)	Time (Min/100 ft.)	Diameter (Inches	Time (Min/100 ft.)
3	0.2	15	2.1
4	0.3	18	2.4
6	0.7	21	3.0
8	1.2	24	3.6
10	1.5	27	4.2
12	1.8	30	4.8

H. The table gives the required test time in minutes per 100-foot lengths of pipe for a given diameter. If there is more than one pipe size in the section of line being tested, compute the time for each diameter, and sum the times to find the total required test time.

I. If the pipe installation fails to meet these requirements, the Contractor shall determine at his or her own expense the source or sources of leakage and shall repair (if the extent and type of repairs proposed by the Contractor appear reasonable to the Engineer) or replace all defective materials or workmanship. The completed pipe installation shall meet the requirements of this test before being considered acceptable.

J. Since this test does not determine the tightness of manholes, they shall be tested separately. See manhole testing under Manhole section.

END OF SECTION

SECTION 334100

DRAINAGE SYSTEM

(For areas beyond five feet outside the building)

PART 1 - GENERAL

1.0 DESCRIPTION:

A. Work Included: Furnish all labor, materials, equipment, and incidentals necessary to completely install all drainage systems as specified herein, as shown on the Drawings, or as directed by the Engineer. The owner shall pay for compaction testing.

B. Related work described elsewhere: Site Earthwork – Section 31 2300.

1.1 SUBMITTALS:

A. Manufacturer's information relative to product compliance with specifications, and installation shall be submitted with the catalog cuts.

B. Owner shall pay for compaction testing.

PART 2 - PRODUCTS

2.0 PIPE AND FITTINGS:

A. Storm pipe shall be as labeled on site plan and in accordance with the following specifications:

1. PVC pipe shall conform in all respects to the latest revision of ASTM Specifications D-3034 or F679, Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, SDR35. Wall thickness of all PVC shall meet ASTM Specifications for SDR35 pipe.

   Joints shall be push-on type using elastomeric gaskets and shall conform to ASTM D-3212. The gaskets shall be factory installed.

2. All smooth walled corrugated HDPE stormpipe shall be silt tight and conform to AASHTOM252, Type S and M294, Type S, and ASTM F405, F667, D2321. The M294 virgin material specification may be waived as approved by the Engineer.

3. Reinforced concrete pipe shall conform to ASTM C76-85A and AASTO No. M170-811.

4. Corrugated galvanized metal pipe shall conform to standard specifications for CGM pipe, AASHTO, M190. Pipe shall have a polymeric coating conforming to AASHTO M246 Type B.

2.1 CATCH BASINS, FRAMES AND GRATES:

A. See details on drawings.

2.2 IDENTIFICATION:

A. Each pipe length and fitting shall be clearly marked with:

1. Manufacturer's name
2. Nominal pipe diameter
3. ASTM designation
4. Material designation
5. PVC cell classification

B. Pipe shall be protected from prolonged exposure to direct sunlight and stored on pallets to insure maintenance of straightness and roundness.

2.3 MISCELLANEOUS MATERIALS:

A. Lubricants, cements, and other construction materials shall be as recommended by the pipe manufacturer.

PART 3 - EXECUTION

3.0 GENERAL:

A. The drainage system shall be installed to the locations shown on the Drawings or as directed by the Engineer.

3.1 JOINTING PIPE:

A. Joints shall be made according to the manufacturer's recommendations.

B. All pipe shall be free from defects. Materials found to be defective shall be removed from the site. The Contractor is responsible for inspecting all material to be used prior to its installation. Defective material which has been installed shall be removed and replaced with non-defective material at the Contractor's expense.

C. The physical and chemical properties of pipe couplings shall be equal to that of the pipe.

D. Pipe cut on the job shall have square ends.

3.2 LAYING PIPE:

A. Pipe and fittings shall be laid according to the manufacturer's recommendations and as follows:

1. Excavate the trench as shown on trench detail;
2. Replace with compacted material as indicated in the excavation and backfill specification and as shown on the Drawings.

B. Lay pipe in an upstream direction.

C. Installation shall conform to manufacturer's recommendations.

3.3 CLEANING:

A. Open ends shall be protected to prevent the entrance of debris.

B. Prior to testing sanitary lines, thoroughly clean the pipe.

C. All pipe and fittings must be free of any foreign matter before final inspection.

D. All catch basin sumps shall be cleaned as required and at the end of the job.

PART 4 - REFERENCE

A. All work relating to the preceding specifications, unless otherwise noted, shall be accomplished in accordance with the State of Vermont Agency of Transportation "Standard Specifications for Construction", dated 2018 and applicable State and Federal laws.

END OF SECTION

SECTION 337119

ELECTRICAL UNDERGROUND DUCTS AND HANDHOLES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rigid steel conduit.
2. Plastic conduit.
3. Plastic duct.
4. Handholes.

B. Related Sections:
1. Section 260553 – Identification for Electrical Systems: Product and execution requirements for underground warning tape.
2. Section 312000 - Earthwork: Product and execution requirements for excavation, trenching and backfill required by this section.
3. Section 337900 – Site Grounding

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

B. ASTM International:
1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
2. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
3. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
4. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
5. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.

C. Institute of Electrical and Electronics Engineers:
1. IEEE C2 - National Electrical Safety Code.

D. National Electrical Manufacturers Association:
1. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
2. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
3. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
4. NEMA TC 6 - PVC and ABS Plastic Utilities Duct for Underground Installation.
5. NEMA TC 9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
6. NEMA TC 10 - PVC and ABS Plastic Communications Duct for Underground Installation.
7. NEMA TC 14 - Filament Wound Reinforced Thermosetting Resin Conduit and Fittings.

E. Underwriters Laboratories Inc.:
1. UL 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit.

1.3 SYSTEM DESCRIPTION

A. Interconnected system of encased conduits, ducts, manholes and handholes to distribute medium-voltage power, telephone, data communications, fire alarm, security, exterior branch circuit wiring, and exterior lighting branch circuit wiring.

B. Conduit, duct routing, manhole and handhole locations are shown in approximate locations unless dimensions are indicated. Route and locate to complete duct bank system.

C. Ducts and conduits routed to the future building site shall be terminated 5’-0” from the building foundation line. All ducts terminated in this fashion shall be capped and provided with drag lines

D. Communications, Audiovisual and Security: Use Schedule 40 PVC underground conduit. Provide rigid steel conduit sweeps up into bases and structures.

E. Exterior branch circuit and lighting: Use Schedule 40 PVC underground conduit. Provide rigid steel conduit sweeps up into bases and structures.

1.4 SUBMITTALS

A. See Division 01 – General Requirements.

B. Product Data: Submit for metallic conduit, nonmetallic conduit, ducts, and handholes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 SUSTAINABLE DESIGN SUBMITTALS

A. See Division 01 – General Requirements.

B. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
1. Materials Resources Certificates:
a. Certify source and origin for salvaged and reused products.
b. Certify recycled material content for recycled content products.
c. Certify source for local and regional materials and distance from Project site.

C. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.
1. Provide cost data for the following products:
a. Salvaged products.
b. Reused products.
c. Products with recycled material content.
d. Local and regional products.

1.6 CLOSEOUT SUBMITTALS

A. See Division 01 – General Requirements.

B. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes and handholes.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.8 COORDINATION

A. See Division 01 – General Requirements.

B. Coordinate Work with existing underground utilities and structures.

PART 2 PRODUCTS

2.1 RIGID STEEL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: See Division 01 - General Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 PLASTIC CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Allied Tube and Conduit.
4. Substitutions: See Division 01 - General Requirements.

B. Fittings and Conduit Bodies: NEMA TC 3.

C. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, with fittings and conduit bodies to NEMA TC 3.

2.3 UNDERGROUND WARNING TAPE

A. Manufacturers:
1. Brady Corporation
2. Brimar Industries, Inc.
3. Seton Identification Products
4. Substitutions: Division 01 - General Requirements.

B. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil (0.1 mm), unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:
1. Tape for Buried Power Lines: Black text on red background.
2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.4 HANDHOLES

A. In-Ground Handholes: Stackable, open bottom, as manufactured by Qauzite Co.:
1. Material: Precast polymer concrete.
2. Cover: Traffic rated precast concrete.
3. Cover Legend: "ELECTRIC" or “TELEPHONE”.
4. Provide sizes as indicated on drawings.

B. Description: Molded composite handhole comprising modular, interlocking sections complete with accessories.

C. Loading: ASTM C857, Class A-16.

D. Covers: Molded composite with tamperproof fasteners. Furnish cover marked to indicate utility.

PART 3 EXECUTION

3.1 EXAMINATION

A. See Division 01 – General requirements.

B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

C. Verify locations of manholes and handholes prior to excavating for installation.

3.2 INSTALLATION - DUCT BANK

A. Install duct to locate top of ducts at depths as indicated on Drawings.

B. Install conduit and duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope conduit and duct toward manholes and away from building entrances.

C. Cut conduit and duct square using saw or pipe cutter; de-burr cut ends.

D. Insert conduit and duct to shoulder of fittings; fasten securely.

E. Join nonmetallic conduit and duct using adhesive as recommended by manufacturer.

F. Wipe nonmetallic conduit and duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

G. Install no more than equivalent of three 90-degree bends between pull points.

H. Install fittings to accommodate expansion and deflection.
   1. Use suitable separators and chairs installed not greater than 4 feet on centers. Secure separators and chairs to trench bottom prior to backfill.

I. Band conduits and ducts together before backfilling.

J. Securely anchor conduit and duct to prevent movement during backfilling.

K. Provide suitable pull string in each empty duct except sleeves and nipples.

L. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.

M. Seal conduit entry to buildings with spray foam watertight sealant after cable is installed and tested with Polywater AFT spray foam sealant or approved equal.

N. Backfill trenches in accordance with Section 312000.

3.3 INSTALLATION - PRE-CAST HANDHOLE

A. Excavate for handhole installation in accordance with Section 312000.

B. Install and seal precast sections in accordance with ASTM C891.

C. Install handholes plumb.

D. Backfill handhole excavation in accordance with Section 312000.

END OF SECTION

SECTION 337900

SITE GROUNDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rod electrodes.
2. Active electrodes.
3. Exothermic connections.
4. Mechanical connectors.
5. Wire.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE C2 - National Electrical Safety Code.

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SYSTEM DESCRIPTION

A. Rod electrodes for local grounding at utility transformer, generator and site structures.

1.4 PERFORMANCE REQUIREMENTS

A. Overall Resistance to Ground: 25 ohms.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate layout and installation details of grounding components.

C. Product Data: Submit data for grounding electrodes and connectors.

D. Test Reports: Indicate overall resistance to ground.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of electrodes and connections.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers:
1. Copperweld, Inc.
2. Erico, Inc.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description:
1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.
3. Length: 10 feet.

C. Connector: Connector for exothermic welded connection.

2.2 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Cadweld, Erico, Inc.
2. Copperweld, Inc.
3. ILSCO Corporation.
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical.
6. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.3 MECHANICAL CONNECTORS

A. Manufacturers:
1. Copperweld, Inc.
2. Erico, Inc.
3. ILSCO Corporation
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical.
6. Substitutions: Section 01 60 00 - Product Requirements

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 WIRE

A. Material: Stranded copper.

B. Horizontal Electrodes: 4/0 AWG, minimum size.

C. Connections to Electrodes: 2/0 AWG, minimum size.

D. Bonding Other Objects: 2 AWG, minimum size.

E. Mechanical Connector: Bronze.

F. Grounding Boxes: Bronze.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install rod electrodes in vertical position with bottom at least 5 feet below frost line.

B. Install interconnecting wire 2 feet below frost line.

C. Provide chemical treatment at each vertical electrode site.
1. Saturate treatment chemicals with water following application.
2. Dig circular trench centered on electrode. Make trench 12 inches deep with 18 inch inside diameter. Uniformly distribute 50 lb of treatment material in bottom of trench and cover with topsoil.

3.3 FIELD QUALITYCONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13. Make final grounding system measurements three or four days after chemical treatment.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate location of each accessible grounding connection and each chemical treatment well.

END OF SECTION