### NEW CLASSROOMS AND LIBRARY BUILDINGS
SOUTHWEST TEXAS JUNIOR COLLEGE – EAGLE PASS
FERRELL/BROWN AND ASSOCIATES

STRIDDE, CALLINS & ASSOCIATES, INC.
F-6328

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1.1 GENERAL CONDITIONS

A. Sections of the Specifications covering general and supplemental conditions are a part of the contract and Contractors shall observe all of the requirements thereof, insofar as they pertain and are applicable to their respective work. Reference to Contractor or Contractors shall imply Mechanical (Plumbing and HVAC) and Electrical Contractors.

B. Contractors shall examine all Drawings and Specifications, visit the sites of the proposed construction, become fully informed as to the extent and character of the work required, and make provisions for same in his bid. It will be assumed that the Contractor in submitting his bid has visited the premises and his bid covers all work necessary to properly install his work.

C. If any requirements of the Drawings and the Specifications appear to be difficult to perform, or if there is a question regarding performance, Contractor shall report same to the Architect during the bidding period. The right to make any reasonable change in the location of outlets, apparatus, and equipment up to the time of rough-in is reserved by the Architect without involving any additional expense.

D. If any discrepancies occur during construction between work being performed by the Contractor and work of other trades, it shall be the responsibility of the Contractor to notify the Architect immediately. Under no circumstances shall the Contractor proceed with any work conflicting with other trades until such time as the discrepancies have been corrected. In cases where interference develops, Architect shall decide which work is to be relocated regardless of which was first installed.

E. Contractor shall proceed with his work so as to conform to the progress of the work of other trades and not delay the project. Contractor shall complete all installations as soon as the conditions of the project will permit.

1.2 SCOPE OF WORK

A. Work to be done under this contract shall include the furnishing of all labor, materials, apparatus, and connections to complete, in finished operating condition, the work for New Classrooms and Library Buildings, Southwest Texas Junior College, Eagle Pass, Texas.

B. Contractor shall take into account that deviations from routing and layout of new work indicated on the Drawings may be required to avoid interference with existing structure and facilities. Contractor shall be responsible for rerouting of existing conduit, piping, etc., to avoid interference with new work if deviations in routing of new work cannot be made to avoid interference with existing conditions. Wiring, piping, ductwork, etc., which serves loads or areas to remain
in use either temporarily or permanently will be rerouted as required and as directed to preserve continuity of service.

C. All items of labor, material, or equipment not required in detail by the Specifications or Drawings, but incidental to, or necessary for the complete installation and proper operation of all phases of work described herein, or reasonably implied in connection therewith, shall be furnished as if called for in detail by the Specifications or Drawings.

D. Existing underground utilities are not indicated on the Drawings. The existing underground utilities indicated are diagrammatic only. The Contractor shall be responsible for jobsite locating and protecting all existing underground utilities prior to trenching or pier drilling.

1.3 WORKMANSHIP

All labor shall be performed in the best and most workmanlike manner by mechanics skilled in their particular trades. All installations shall be complete in both effectiveness and appearance whether finally enclosed or left exposed. Architect reserves the right to direct the removal or replacement of any item which in his opinion shall not present a reasonable neat or workmanlike appearance, providing that same can be properly installed in an orderly way by usual method for such work. All specialties and appurtenances shall be installed to conform to the manufacturer's recommendations unless otherwise specified.

1.4 CODES, PERMITS, AND FEES

A. Entire installation shall be done in strict accordance with all local, state, and federal ordinances, codes, and regulations.

B. In the event there is a conflict between the Drawings and Specifications and the applicable codes, ordinances, and regulations, the codes, ordinances, and regulations requirements shall govern. However, if the contract requirements are in excess of these requirements and do not conflict with the requirements, the contract provisions shall govern. If any work indicated on the Drawings is in conflict with codes, ordinances and regulations, Contractor shall advise Architect at least one (1) week prior to bid date so that discrepancies may be corrected by an addendum to the Drawings and Specifications. Failure by the Contractor to advise of any discrepancies shall leave the Contractor fully and completely responsible for compliance with all applicable codes and requirements.

C. All work shall comply with Standards contained in applicable NFPA pamphlets, all as published by the NFPA (National Fire Protection Association).

D. Contractor shall obtain all permits and pay all fees necessary in connection with his work.
1.5 SAFETY STANDARDS

It shall be Contractor's sole responsibility to initiate, maintain, and supervise all safety precautions required by local, state, and federal laws, including OSHA (Occupational Health and Safety Administration) and trench safety laws.

1.6 MATERIALS AND EQUIPMENT

A. All materials and equipment furnished under this contract shall be in strict accordance with these Specifications, and shall be new. Equipment shall be of the latest or current products available. When two (2) or more articles of the same materials or equipment are required, the articles of each kind shall be standard products of a single reputable manufacturer. Electrical materials and equipment shall bear the label of UL (Underwriters Laboratories, Inc.).

B. All materials and equipment shall be clearly marked, stamped, or labeled for identification. Identification marks or labels shall be plainly visible for inspection and shall not be obscured or obliterated in any manner. Painting or covering shall not be done until so ordered by the Architect.

C. Contractor shall furnish to the Architect, within a reasonable time after award of contract, and prior to commencing any work, complete brochures of all materials and equipment which the Contractor proposes to furnish on the project. Data shall include descriptive literature, performance data, diagrams, capacity information, etc., to substantiate that proposed equipment physical size and capacity will meet all of the requirements of the Drawings and Specifications.

D. All data must be checked and any required changes indicated thereon by the Contractor, signed, and dated prior to furnishing same to the Architect for approval. Contractor's attention is directed that it is mandatory that he thoroughly review data prior to furnishing same to assure that equipment is in accordance with Drawings and Specifications and to assure prompt return of the data.

E. Each brochure shall be neatly organized into a single binder or electronic PDF file. In each brochure provide cover sheet identifying project name and location, Architect, Engineer, General Contractor, and Mechanical, Electrical, or Plumbing Contractor. Include Contractor's addresses and phone numbers. Provide adequate space for Architect's and Engineer's stamps. Provide quantity of submittal copies required by other sections of the Specifications.

F. If above information is not provided complete as specified above and within the allocated time, all equipment shall be furnished exactly as specified without any substitutions.

G. In furnishing data of proposed equipment and materials, Contractor must, in writing, specifically call to the attention of the Architect every deviation from the Contract Drawings and Specifications.

H. Review of data, drawings, etc., shall not be construed as releasing the Contractor from further responsibility, but rather as a means to coordinate the
work and to aid in the proper selection and installation of the equipment. All material and equipment shall be subject to final acceptance by the Architect at the completion of the project.

1.7 WARRANTY

A. Any defects from defective or improper materials or faults arising from improper workmanship which may appear within a period of twelve (12) months from the date of final acceptance of the building shall be amended and made good by the Contractor at his own cost. Architect shall furnish to the Contractor a letter indicating the date of final acceptance.

B. Where such defective work results in damage to the work installed under other sections of the Specifications, all such work shall be restored to its original condition at the expense of the Contractor by parties skilled in the particular work required.

1.8 DRAWINGS

A. These Specifications are accompanied by Drawings indicating typical layouts, pipe, conduit sizes, outlet and equipment locations, etc. Drawings and these Specifications are complementary each to the other and what is called for by one shall be as binding as if called for by both. All electrical outlets indicated on the Drawings are schematic. Exact location of each outlet shall be based upon exact architectural dimensions and related mechanical details.

B. Drawings as prepared are in general diagrammatic. Contractor shall carefully lay out his work at the site to conform to existing conditions, architectural, structural, mechanical, and electrical conditions, to avoid all obstructions and to conform to details of installation as indicated on the Drawings and supplied by the manufacturers of the equipment to be installed and thereby to provide an integrated, satisfactorily operating installation. All necessary offsets in piping, fittings, etc., required to avoid interferences between piping, equipment, architectural, and structural shall be furnished and installed by the Contractor without additional expense to the Owner or Architect.

C. Routing paths for all piping, power feeders, and branch circuits are not indicated on the Drawings. Routing paths which are indicated are schematic and are not accompanied by dimensional data or detailed for every required offset. Contractor shall have his choice of routing paths for such piping and raceways provided that this routing does not interfere with existing conditions and does not violate the requirements of the Owner. In cases where inference develops or in cases where proposed routing is not in accordance with the requirements of the Owner, a representative of the Owner will direct the required path of routing. All trenching, tunneling, piping, conductors, conduit, boxes, fittings and supports required to install piping and raceways indicated on the power riser diagram, and floor plans are herby included in the project requirements and shall be included in the proposal submitted by the Contractor.

D. These Specifications and Drawings accompanying same are intended to cover systems which will not interfere with new building conditions, which will fit into the
available spaces, and which will ensure complete and satisfactory systems. Contractor shall, therefore, carefully examine the Drawings and the building and shall be responsible for the proper fitting of his material and apparatus into the building.

E. Contractor's attention is directed that all equipment he proposes to furnish must fit into the space allocated for same on the Drawings. It shall be the Contractor's responsibility to furnish data to evident that sufficient space can be provided for the installation of proposed equipment and that adequate access will exist for service and maintenance of equipment. Should changes become necessary during construction, the Contractor shall make such necessary changes at his (the Contractor's) own expense.

1.9 CHANGES

Any changes from the Drawings necessary to make the installation conform to building construction, to make this work fit the work of other trades, or to make this work conform to the rules of the city and municipal bodies having jurisdiction shall be made by the Contractor at his (the Contractor's) own expense.

1.10 PROTECTION

All work, equipment, and materials shall be protected at all times to prevent damage or breakage either in transit, storage, installation, or testing. All openings shall be closed with caps or plugs during installation. All material and equipment shall be covered and protected against dirt, water, chemicals, or mechanical injury. Failure on the part of the Contractor to provide adequate protection will be cause for rejection of the unprotected equipment and materials.

1.11 CUTTING AND PATCHING

A. Where existing surfaces are disturbed, cut, or damaged and these surfaces are exposed to view in finished areas, Contractor shall replace same with materials and finish matching existing surfaces. All patches, etc., shall thoroughly bond with the original surfaces and shall be level with same. Cutting and patching of existing surfaces shall be done by parties skilled in that particular work. All openings around conduits or piping through floors or walls shall be grouted and sealed.

B. Work shall be carefully laid out in advance and the exact size and locations of openings required shall be furnished to the General Contractor. Contractor shall be responsible for the furnishing and setting for the proper and permanent location of all sleeves, hangers, supports, inserts, plates, etc. If any cutting of the construction is necessary because of erroneous locations or to patch openings not used, the work shall be done at the expense of the Contractor by parties skilled in that particular work. No cutting or core drilling shall be done without permission of the Architect. All drilling and patching for expansion bolts, hangers, and other supports shall be done by the Contractor, subject to the approval of the Architect.
C. Contractor’s attention is directed that existing roofs are bonded roofs and warranty of work cannot be disrupted. Cutting and patching of roofs, mopping new equipment and pipe supports into existing roof, cutting new duct penetrations through roof, and flashing/sealing roof curbs into existing roof shall be done in accordance with instructions, method, etc., of a roofing Contractor approved by the Owner.

1.12 EXCAVATION AND BACKFILL

Each Contractor shall provide all necessary excavation and backfilling required for his work. Excavation shall be backfilled with approved material tamped and puddled compactly in place to a density required to leave surface of ground at original level without settlement.

1.13 SLEEVES

A. All piping (except uninsulated copper piping) and conduits which pass through new floors and exterior walls shall be provided with pipe sleeves. Copper pipe sleeves shall be used for uninsulated copper piping.

B. Sleeves must be secured in place and plumb. Sleeves must be of sufficient size so as to allow approximately 1/4" space between the sleeve and the pipe or, if the pipe is insulated, 1/4" space between the sleeve and the insulation.

C. All piping and conduit passing through the floors or exterior walls shall have the space between the sleeve and the pipe or conduit packed and caulked watertight and rodent proof.

1.14 CERTIFICATION OF INSTALLATION BY EQUIPMENT MANUFACTURER’S REPRESENTATIVE

A. In order to place responsibility for the furnishing of the proper equipment and to see that it is installed as intended by the manufacturer, the Contractor, during construction, shall request supervisory assistance from the equipment manufacturer’s representatives so that the material installation will be properly installed. After installation, the Contractor shall again request the representatives to inspect and certify that the equipment is in proper working order.

B. Before final payment is issued, the representatives shall submit to the Architect, through the Contractor, a signed statement certifying to their inspection and that the equipment is properly installed and ready for operation.

1.15 VIBRATION AND NOISE

Vibration and noise made in any part of the building by the operation of the Contractor’s equipment will be objectionable and the Contractor shall take all precautions against same by isolating the various elements from the building and by such other means as may be necessary to eliminate all vibration and objectionable noise.
1.16 ESCUTCHEONS

Where exposed pipes pass through floors, walls, or ceilings, they shall be fitted with chromium plated stainless steel escutcheons firmly secured to the pipes and held in place with set screws.

1.17 FIRE PROTECTION/SOUND ATTENUATION SEALANT

A. All pipe, conduit, etc., penetrations through fire separation walls, partitions, floors, etc., shall be sealed with firestop sealant or foam system. Firestop sealant or foam shall be UL classified for the application, shall have intumescent characteristics, and shall be listed (1 hour, 2 hour, 4 hour) to match the rating of surface penetrated.

B. All pipe, conduit, etc., penetrations through walls, partitions, floors, etc., which are not fire rated but are intended to attenuate sound shall be sealed with expandable foam or other material to provide sound barrier.

1.18 DEMOLITION AND WORK WITHIN EXISTING BUILDING

A. This project shall be accomplished as required to accommodate the Owner's need to utilize existing campus buildings/facilities during the course of construction. During the construction, the existing campus buildings/facilities shall remain in service. Interruption of services to existing campus facilities and/or disruption of Owner activities will not be permitted.

B. In the preparation of these documents, effort has been made to show the approximate locations of, and connections to the existing piping, duct, equipment and other apparatus related to this phase of the work. However, the Contractor shall be responsible for verifying existing conditions which are associated with new work. Contractor shall visit the site to inspect the facilities and related areas. Contractor shall inspect and verify all details and requirements of all the contract documents, prior to submittal of proposal. All discrepancies between the contract documents and existing conditions shall be reported to the Architect during the bidding period.

C. Conduit, power and control wiring, pipe, duct, equipment and controls serving mechanical, plumbing, electrical, Owner's equipment, etc., which is to remain but which is served by conduit, pipe, duct, equipment, and controls that are disturbed by the remodeling work, shall be reconnected in such a manner as to leave this equipment in proper operating condition.

D. No portion of the existing fire protection or security alarm systems shall be turned off, modified, or changed in any way without the knowledge and written permission of the Owner's representative.

1.19 CONTINUITY OF SERVICE

A. At no time during the progress of the work shall the Contractor interrupt the continuity of any of the required services to existing campus buildings/facilities during regular scheduled usage by Owner. It shall be the responsibility of the
Contractor to take the necessary precautions and to plan the sequence of his work so that this may be accomplished. To this end, the necessary temporary services and connections which will be required to provide continuity of the required services are hereby included in this Specification.

B. Where service interruptions are required, the Contractor shall arrange a minimum of 72 hours in advance by written notice to the Owner for the service interruption and shall submit for approval, a proposal indicating the extent of time of the interruption and the service or facilities that will be interrupted. Final time which will be scheduled will be that approved by the Owner.

1.20 REMOVED MATERIALS, FIXTURES, AND EQUIPMENT

A. Certain existing materials, fixtures, devices, and equipment are to be removed. Fixtures, devices and equipment which are selected by the Owner shall remain the property of the Owner. Such fixtures, devices and equipment shall be delivered by the Contractor to a designated location at the site of construction. Fixtures, devices, and equipment which are not selected by the Owner shall become the property of the Contractor. Such devices, fixtures, and equipment shall be removed from the premises by the Contractor. Contractor shall exercise extreme care in removing any fixtures, devices and equipment to be retained by the Owner.

B. All removed electrical, plumbing, and HVAC materials shall become the property of the Contractor. Such materials shall be removed from the site of construction and properly disposed of.

1.21 CLEANING

Contractor shall thoroughly clean all equipment, materials, and devices furnished and set by him. Contractor shall remove all of his debris that may have accumulated during the job. After the Architect inspects the equipment, any discrepancies shall be amended as directed.

1.22 USE OF ENGINEERS ELECTRONIC DRAWINGS

The Contractor may request the use of electronic copies of the Engineers Drawings for preparation of Contractor shop drawings. All such requests must be presented to the prime design firm. Upon receipt by the Engineer of the executed Engineer’s standard Waiver of Indemnification and upon receipt by the Engineer of compensation in the amount of two hundred fifty dollars ($250) to receive Drawings by mail and two hundred dollars ($200) to received Drawings electronically. The Engineer will forward requested Drawings (with Engineering seal removed) through the prime design firm for use by the Contractor.

1.23 OWNER TRAINING

A. Owner training is required by other sections of these Specifications. The Contractor must include evidence of completed Owner training with (bound within) the Operation and Maintenance manuals. Such evidence of completed Owner training shall include the following:
1. Owner training log to include:
   a. Typewritten names with job titles and signatures for each person in attendance.
   b. The time, date, and duration of each training session.
   c. A comprehensive list of all training topics covered.
   d. A comprehensive list of all demonstrations and/or hands-on training for items such as systems programming, maintenance techniques, etc.

2. Copy of audio and/or video recordings of training sessions where such recordings are required by other sections of these Specifications.

END OF SECTION
PART 1  GENERAL

1.1  SCOPE

A. The Work to be provided under this Division of Specification shall include the furnishing, delivering, transporting, unloading, hoisting, handling, scaffolding, storing, erecting, adjusting, and testing of all materials, apparatus, and equipment required for complete, properly adjusted and operable mechanical systems for the New Classrooms & Library Buildings, Southwest Texas Junior College, Eagle Pass, Texas Campus project in accordance with the Contract Documents. Provide all labor, supervision, coordination, equipment, tools, materials, permits, fees, and connection to utilities necessary for the completion of this Work.

B. If details or special conditions are required in addition to those shown on Drawings, provide all material and equipment usually furnished with such systems or required to complete their installation, whether noted in Contract Documents or not.

C. The Instructions to Bidders, Notice to Bidders, General Conditions, Special Conditions, all other preface Sections, all technical divisions and all appendixes of the Specifications, and any other pertinent documents issued by Owner’s representative shall be considered as part of this Division insofar as they may be applicable.

D. The Architectural, Civil, Structural, Plumbing, Fire Protection, Heating, Ventilating and Air Conditioning (HVAC) and Electrical Plans and Specifications and any other pertinent documents issued by Owner’s representative shall be considered as part of this Division insofar as they may be applicable.

E. All work inside existing Student Services Building shall be performed by Owner. Contractor is responsible for relocating existing condensing units, including disconnection, reconnection, and restarting existing equipment. Existing condensing units to be temporarily relocated, reconnected and put back into service prior to new condensing units being installed on the roof of new Administration Building. Refrigerant piping and controls to be extended and connected to existing air handling units in Student Services Building. Electrical Contractor to provide raceway to new Administration Building roof for controls.

1.2  CODES AND STANDARDS

A. The Codes and Standards of the following organizations shall generally apply where applicable and where no specific Codes and Standards have been cited. In the event of conflict between the Codes and Standards of these organizations, the more stringent shall govern.
ADC: Air Diffuser Council.
ARI: American Refrigeration Institute.
ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers.
ASME: American Society of Mechanical Engineers.
ASPE: American Society of Plumbing Engineers.
AWS: American Welding Society.
CGA: Compressed Gas Association.
CTI: Cooling Tower Institute.
FM: Factory Mutual Engineering Company.
IRI: Industrial Risk Insurers.
ISA: Instrument Society of America.
MSS: Manufacturers Standardization Society.
NBS: National Bureau of Standards.
NEMA: National Electrical Manufacturer's Association.
OSHA: Occupation Safety and Health Administration.
PDI: Plumbing and Drainage Institute.
PFI: Pipe Fabrication Institute.
SMACNA: Sheet Metal and Air Conditioning Contractors National Association.
UL: Underwriters Laboratories, Inc.

B. All workmanship, material, and equipment shall be in accordance with all local, state, and federal codes, ordinances and regulations.

1.3 DEFINITIONS

A. "Contract Documents" shall refer to the complete package of Plans, Specifications, addenda, and special conditions used as a basis for the General Construction Contract for this project including but not limited to all General and Special Conditions, all Architectural and Engineering Divisions of Specifications and all Architectural and Engineering Plans.

B. "Owner" means the entity specified in the General Construction Contract as Owner.

C. "Contractor" means the entity contracting with the Owner for the performance of work.
D. "Work" means all of the Contractor’s obligations under the Contract.

E. "Provide" shall mean furnished and installed, complete and ready for intended use by Contractor, except as otherwise noted.

F. "Furnish" shall mean purchase only by Contractor; installation by others, except as otherwise noted.

G. "Install" shall mean Contractor to set up for use, erect or construct only; purchase by others, except as otherwise noted.

H. "Demolish" and "Remove" shall mean Contractor to disassemble, take away from site, and properly dispose of items as indicated or implied. Contractor shall patch remaining systems to match existing.

I. "Directed" means "directed by Owner’s representative". This shall not imply that Architect’s or Engineer’s responsibility extends into the Contractor’s area of construction supervision.

J. Where the words "similar" or "typical" are used, they shall be used in their general sense and shall not be interpreted as meaning identical. Details shall be worked out in relation to their location and connections to other parts of work.

K. Items such as but not limited to access doors, sleeves, cleanouts, trap-primers, roof flashings, pipe supports, or balancing dampers that are to be installed repetitiously and are noted on the Plans as "typical" shall be installed at every location required by Specifications, codes, or good practice, whether specifically shown on Plans or not.

L. Where the terms "or equal" and "or approved equal" are used they shall be defined as "approved as equal by Owner’s representative".

1.4 CONTRACTOR’S RESPONSIBILITY

A. It shall be the responsibility of the Contractor to carefully examine all of the Contract Documents and to comply with them in every respect. Should there be omissions or discrepancies in the documents notify the Owner’s representative prior to the bid date so a written clarification can be issued.

1. Coordinate exact electrical requirements of all mechanical equipment prior to submittal review and make all modifications necessary for full compatibility with the final electrical installation.

B. It shall be responsibility of the Contractor to review all Divisions of the Contract Documents with respect to mechanical work that will be required by other divisions. Contractor shall thoroughly review all aspects of Mechanical Bid Proposal prior to bidding for the purpose of clearly defining the scope of Mechanical Bid Proposal with that of all other trades.
C. It shall be the responsibility of the Contractor to provide all equipment, materials, and labor, whether specifically indicated on Plans or called for in Specifications or not, which are necessary for the proper installation and function of the mechanical systems for this project.

D. It shall be the responsibility of the Contractor to carefully examine conditions of the project site and to check the work of other divisions that might affect the mechanical work. Include all costs of demolition, cutting, patching, and repairing of existing elements in bid proposal.
1. Visit the proposed project site prior to bid and carefully investigate existing streets, parking lots, paved areas, sidewalks, buildings, structures, and landscaping.

E. It shall be the responsibility of the Contractor to contact the Owner's representative prior to commencement of any trenching or site utility work for assistance in locating underground utilities. Hand dig where necessary to verify depth and location and to avoid damage to existing.

F. It shall be the responsibility of the Contractor to coordinate work performed under the Mechanical Division of the Contract Documents with work performed under other divisions so as not to delay or damage any part of this installation.

G. It shall be the responsibility of the Contractor to coordinate the location of chases, openings, sleeves, flashings, trenches, and the like required for the work covered by the Mechanical Division of the Contract Documents. Do so in sufficient time for proper coordination with general construction, or assume the responsibility for required cutting and patching. No cutting of structural members shall be performed without approval of the Owner's representative.

H. It shall be the responsibility of the Mechanical Division to include minor details necessary for proper installation and operation of materials, equipment, or fixtures as if specified or shown in Contract Documents.

I. It shall be the responsibility of the Contractor to install materials, equipment, and fixtures according to code requirements, manufacturer's recommendations or as required in Contract Documents, whichever is more stringent.

1.5 ADDITIONAL COMPENSATION

A. Failure to examine or to comply with Contract Documents shall not relieve Contractor of responsibility for the work or be used as basis for additional compensation.

B. No additional compensation will be awarded for conflict with Architectural, Structural, Electrical, or Mechanical components in installation of prefabricated materials or equipment.
1. Ductwork and piping shall be fabricated from field measurements. Adjust duct sizes as necessary to fit space available. Contractor shall advise Owner's representative of any discrepancies prior to fabrication.
C. No compensation will be awarded to the Contractor for minor relocations or deviations from plans. Changes in contract price will be allowed only for additions to or changes to original design intent and then only with written approval of the Owner’s representative.

D. Omission of Architectural, Civil, Structural, Electrical, or other pertinent details from Mechanical Contract Documents shall not be used as basis for additional compensation.

E. No compensation will be awarded to the Contractor for failure to coordinate exact electrical requirements with electrical division prior to ordering equipment.

1.6 SUPERVISION, LABOR, AND WORKMANSHIP

A. Contractor shall provide proper supervision of mechanics and subcontractors performing work under this Division. Labor shall be performed by skilled mechanics experienced in their particular trade. Piping and equipment shall be installed square and plumb, with accessibility for proper operation and service. Any item that does not present a neat and workmanlike appearance shall be replaced or corrected at the direction of the Owner’s representative and without additional cost to the Owner or Design Professionals.

B. Submit welder’s certificates and resume of experience for all mechanics on this project when directed to do so by Owner’s representative.

1.7 FEES AND PERMITS

Contractor shall obtain and pay for all fees and permits required for the completion of the Work, including but not limited to construction permits; federal, state, and local inspection fees, connections to utilities, meter and tap fees, capitalization charges, temporary service charges, and any other associated fees or charges.

1.8 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. These Specifications and the accompanying Drawings are intended to describe and illustrate systems which will not interfere with the structures, which will fit into available spaces, and which will ensure complete and satisfactorily operating installations. Coordinate the proper fitting of the material and apparatus into the available spaces without interfering with other building components. Prepare installation drawings at all locations where possible conflicts of HVAC, Plumbing, Fire Protection, Electrical, Structural, or Architectural components may occur. The installation drawings shall be submitted to the Owner’s representative prior to commencing the Work. They should illustrate the installation of work in relation to other portions of the Work. Interferences with other portions of work, or the building structure, shall be corrected before the work proceeds. Should changes become necessary on
account of failure to comply with these stipulations, make such necessary changes.

1.9 PRE-INSTALLATION CONFERENCE

A. Contractor shall convene a pre-installation conference one (1) week prior to commencing work of this Division and in conjunction with work of other divisions and notify Owner’s representative of date and time of meeting.

B. Require attendance of parties directly affecting work of Division 15 and 16.

C. Review installation procedures and coordination required with related work.

D. Establish “right of way” and routes for conduit, wiring, cable trays, piping, ductwork, and similar elements in the available space above ceilings and vertical chases.

E. Coordinate exact plumbing, fire protection, electrical, and service access requirements of all HVAC equipment and fixtures. Coordinate exact HVAC and service access requirements of all plumbing, fire protection, and electrical equipment, as example, ventilation and exhaust of panelboards, transformers, generators, pumps, water heaters, or boilers. Advise Owner’s representative of any requirements that will be necessary in addition to requirements on Contract Documents.

1.10 GENERAL REQUIREMENTS

A. Protection of Rough Work: All openings of every description shall be securely capped or otherwise protected against debris or other foreign material entering the system until such time as the equipment is permanently attached.

B. Cleaning and Adjusting: At the completion of the work all parts of the installation shall be thoroughly cleaned. All valves and controls shall be adjusted for proper operation. Upon completion of the work, the Contractor shall leave the building and project site in a neat condition.

C. Defective work: If inspection or testing show defects, such defective work or materials shall be replaced and inspection and test repeated. All repairs to piping shall be made with new material. No caulking of screwed joints will be acceptable.

D. Dielectric Connection: Where dissimilar metals are connected, provide approved dielectric connector to protect against dielectric corrosion.

E. Vents Through Roof: Vents through roof shall be installed as closely as possible to locations shown on Drawings. However, in no case shall vents through roof be installed within ten feet of air conditioning outside air intakes. It shall be the responsibility of the Contractor to coordinate with the Plumbing and HVAC Divisions and offset vent piping as necessary. Offsets will be made at no additional cost to the Owner or Design Professionals.
F. Surveys and Measurements: Carefully survey project site prior to bidding and installation. Dimensions, both horizontal and vertical, shall be derived from Architectural, Civil, and Structural plans. Do not "scale" plans; that is do not measure plans with Architect’s or Engineer's scale and base installation dimensions on such measurements.

G. Horizontal and vertical measurements shall be based on established benchmarks. Work shall agree with established lines and levels. Field verify measurements at project site. Check correctness of same as related to work prior to fabrication of shop made items and ordering of factory built items.
   1. Notify Owner’s representative of discrepancies between plans and actual field conditions that will prevent the following of good practice or affect the intent of plans and Specifications. Do not proceed with installation until instructions are received from Owner’s representative.

H. The accompanying plans show diagrammatically the sizes and location of the various equipment items and the sizes of the major interconnecting piping and ductwork, without showing exact details as to elevations, offsets, control lines, and other installation details. The Contractor shall carefully lay out his work to conform to the site conditions, to avoid obstructions and provide proper grading of lines. Exact locations of outlets, apparatus, and connections thereto shall be determined by reference to the accompanying Plans, to all detail drawings, equipment drawings, rough-in drawings, etc., by measurements at the building, and in cooperation with other divisions, and in all cases shall be subject to the approval of the Owner’s representative. Minor relocations necessitated by the conditions at the site or directed by the Owner’s representative shall be made without any additional cost to the Owner.

I. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted on the Drawings.

J. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this Section or work specified in other Sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.

K. Should a discrepancy exist between the mechanical Drawings and the mechanical Specifications it is the Contractor’s responsibility to include that portion or portions of the more expensive item in bid proposal. Final approval and/or directive can then be forwarded to the Contractor during the submittal process.
1.11 FIXTURE AND EQUIPMENT SIZES AND REQUIREMENTS

A. Space allocations in machinery spaces are based on equipment scheduled in each case. Should the Contractor offer equipment of another make that requires more space in any critical dimension, the Contractor shall submit, together with other submittal data on the equipment, prints of drawings indicating how the equipment may be installed, indicating room for servicing and revisions in piping or ducting and any other details necessary for the Owner's representative to form a judgment as to the suitability of the substitute material, as to performance, suitability for the space and other variables.

B. Duties of certain equipment items, horsepower of driving motors and electrical characteristics are scheduled for equipment items of a particular make in each case. Should any substitute material be accepted which has other requirements that would involve allied equipment or the work of others, the Contractor shall be responsible for all modifications required at no change in contract price. As examples:

1. If an accepted A/C Unit has a brake horsepower requirement above the motor horsepower scheduled, the Contractor shall be responsible for providing a larger motor and heavier drive and any change in size of the protective device, conduit run, and conductors serving that motor. The latter shall be extended through an individual branch protective device and branch circuit on through the panel, feeder, feeder protective device, etc.

2. If accepted heat exchangers, coils, etc. have greater pressure drops than those on which pumping heads were based, the Contractor shall be responsible for selecting proper pumps and drive and adjusting the electrical work as required.

C. Structural steel members are indicated to provide supports for certain specific sizes and weights of equipment. Should other equipment be offered, the spacing of the supports shall be varied to suit the equipment. Should the weight or size of a substituted item of equipment require additional supporting steel members, the Contractor shall be required to provide and install them at no change in contract price.

1.12 INTERFACE WITH OTHER PRODUCTS

Review millwork shop drawings. Confirm location and size of equipment and openings before ordering equipment, rough-in, and installation.

1.13 SUBMITTALS

A. Submit in timely manner for review, brochures describing all materials, equipment, fixtures, and specially fabricated structures proposed for use in the performance of the work on this project.

1. Items to be submitted shall include but shall not be limited to ductwork, pipe, valves, fittings, materials, hangers, special supports, insulation, fixtures, equipment, controls, coordination and ductwork fabrication...
drawings, central plant coordination and piping fabrication drawings, refrigerant piping design drawings, and mechanical room layouts.

2. Contractor’s Coordination Drawings: The Contractor shall prepare a complete set of coordination drawings indicating the equipment actually purchased and the exact routing for piping, conduit, and ductwork. The elevations, locations, support points, load imposed on the structure at support and anchor points, and size of all lines shall be indicated. All beam penetrations and slab penetrations shall be indicated and sized and shall be coordinated. This requirement for coordination drawings shall not be construed as authorization for the Contractor to make any unauthorized changes to the Contract Drawings. All Design Drawing space allocations shall be maintained, such as ceiling height, chase walls, equipment room size, and the like, unless proper written authorization is received from the Architect to change them.

B. Submit manufacturer’s data or shop drawings where required by a Section covering a particular system and/or piece of equipment. The manufacturer’s data of shop drawings shall include but not be limited to giving full information as to dimensions, weight, materials, motor sizes, electrical characteristics, wiring diagrams, capacities and all information pertinent to adequacy of items. Contractor is responsible for the timely preparation and submission of ¼”=1'-0” ductwork shop drawings indicating all items necessary for complete coordination and fabrication/installation. Contractor is also responsible for the timely preparation and submission of ½”-1'-0” shop drawings indicating all HVAC equipment, piping, and ductwork in mechanical room areas and or critical areas that mandate a thorough review of the systems. Engineer will review these drawings for compliance and offer comments and or suggestions.

C. Information shall be presented so that line-by-line comparison may be made with Contract Documents. Deviation from Contract Documents shall be enumerated on separate sheet and so entitled. Data of general nature will not be acceptable.

D. Each submittal will be reviewed for compliance with general requirements of design and arrangement only; it is not a Contract document and acknowledgment of compliance does not remove the Contractor of responsibility for performance of the work in compliance with all provisions and requirements of the Contract Documents. Job measurements and the coordination of all the dimensions for proper fit of all parts of the work and performance of all equipment supplies to meet Specification requirements are and remain specific responsibilities of the Contractor.

E. Each submittal shall be neatly organized in binders or a single pdf file with information arranged in order of specification section. Provide a Table of Contents and divider/coversheet for each specification section. Submit Plumbing, Fire Protection, and HVAC divisions independently with a maximum of three separate packages for each division, as example, major equipment, materials, and controls. In each brochure or pdf file provide cover sheet.
identifying project name and location, Architect, Engineer, General Contractor, and Mechanical Contractor. Include Contractor's addresses and phone numbers. Provide adequate space for Architect's and Engineer's stamps. Contractor shall include and sign the following statement of compliance on the cover sheet:

I hereby certify that this shop drawing and/or brochure has been checked prior to submittal and that it complies in all respects with the requirements of the Contract Documents for this project.

(Company Name)
Signed
Date

Submittals forwarded without compliance statement and signature in each brochure will not be reviewed. Contractor will bear the risk of all delays, as if no submittal had been delivered.

Contractor’s statement of compliance shall constitute a representation to the Owner’s representative that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that Contractor has reviewed or coordinated each submittal with the requirements of the work and the Contract Documents.

F. Engineer’s review of submittals does not relieve Contractor of his responsibility for deviations from Contract Documents or errors and omissions except when acceptance of the specific deviation is given in writing.

G. Engineer’s review and approval is only for conformance with the design concept of the project and for compliance with the information given in the contract.
1. The review shall not extend to means, methods, sequences, techniques, or procedures of construction or to safety precautions or programs incident thereto.
2. The review shall not extend to review of quantities, dimensions, weight or gauges, fabrication processes or coordination with the work of other trades.

H. The shop drawings are not intended to cover detailed quantitative lists of heating specialties, valves, air distribution devices, fixtures, and similar items. It is the Contractor's responsibility to procure the proper quantities required to comply with the established requirements.

I. Coordinate exact electrical requirements of HVAC equipment and fixtures with electrical division prior to submittal of brochures.

J. Submit brochures in sufficient time and of proper format so as to avoid delays or changes in construction. Failure to comply shall render Contractor liable for expenses of delays occasioned by failure to provide necessary information or
drawings. Owner’s representative reserves the right to contact manufacturer directly to secure proper data and detail when deemed necessary. Contractor shall be liable for costs incurred by such action.

K. Any shop drawings prepared to illustrate how equipment, piping, ducts, and the like are to be fitted into available spaces will be examined under the assumption that the Contractor has verified all the conditions, and obtaining any approval thereon shall not relieve the Contractor of responsibility in the event the material cannot be installed as shown on those Drawings.

L. Any material or equipment installed without the Owner representative’s prior approval shall, if so directed by the Owner's representative be removed and replaced with approved material or equipment at the Contractor's expense.

M. Any dimensional changes or rerouting of piping or ductwork shall necessitate submittal or shop drawings of the system under consideration prior to fabrication or erection of material. Drawings will be utilized by the Owner's representative to evaluate the effect of the proposed changes on equipment performance.

N. Test Reports: The Contractor shall submit to the Owner's representative all test reports in accordance with details specifically called for in the various Sections of the Specifications in this Division.

1.14 COMMISSIONING OF HVAC SYSTEMS

Upon completion of the HVAC installation, Contractor shall test, balance, adjust, and operate all individual components of the HVAC system. Demonstrate that the installation is functioning in all modes of operation as a complete and integrated HVAC system and is performing in accordance with the Contract Documents. Owner’s personnel shall be trained in the operation and maintenance of the system. All operating schedules, parameters, and set-points shall be entered into the Facility Management System or Automatic Temperature Control system.

1.15 OPERATION OF HVAC SYSTEMS

It is the intent of the HVAC system design to operate HVAC systems continuously, 24 hours a day, 365 days a year, in either occupied or unoccupied modes of operation as described in Section 15975 - Automatic Temperature Controls or Section 15985 - Sequence of Operation to provide for control of space temperature and humidity.

1.16 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Upon completion of work, provide three (3) sets of complete operations and maintenance instructions of mechanical equipment, neatly bound in 3 ring binders. Provide each binder with the name of Owner, Architect/Engineer, Contractor, and Title. During the construction period, accumulate the following for inclusion in the Operating and Maintenance Manuals:
1. Tabulation of equipment by manufacturer, model number, and serial number.
2. All warranties and guarantees and manufacturer's directions on equipment and material covered by the Contractor.
3. Approved fixture brochures, wiring diagrams, and control diagrams.
5. Operating instructions for all mechanical equipment and systems. Operating instructions shall include maintenance and seasonal changeover procedures.
6. Recommended maintenance procedures.
7. Repair parts list of all major items and equipment including name, address, and telephone number of local supplier or agent.
8. Valve tag charts and diagrams specified elsewhere herein.
9. Manufacturer's letter certifying that the equipment has been installed per manufacturer's installation manuals.
10. Contractor's one (1) year warranty letter including start and finish dates.
12. Factory start-up and commissioning reports.

B. Operation and Maintenance instructions shall be submitted and approved prior to instruction of Owner's personnel in the various systems operation and maintenance.

1.17 UTILITIES

The Contract Documents reflect the general location, size, and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local Utility Company personnel in order to coordinate and confirm the exact requirements for all utilities. The bid submitted by the Contractor shall include costs for all such coordination work as well as any and all utility company charges and/or fees.

1.18 BUILDING CONSTRUCTION AND LAYOUT OF WORK

The Contract Documents are diagrammatic in character and cannot show every connection in detail or every line or conduit its exact location. These details are subject to the requirements of ordinances and also Structural and Architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc. shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.
1.19 RECORD DRAWINGS

A. As part of the required mechanical work, a complete set of record drawings shall be made up and delivered to the Owner's representative. The drawings shall reflect the following:
   1. All mechanical work installed exactly in accordance with the original design.
   2. All mechanical work installed as a modification or addition to the original design.
   3. The dimensional information necessary to delineate the exact location of all ductwork and piping runs which are so concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance. Where shop drawings have been prepared and approved, the record drawings shall be cross referenced to the respective shop drawings. In this case dimensions need not be shown on the record drawings.

B. Record drawings shall include the updating of all equipment schedules.

C. The record drawings shall be of a reproducible type as directed.

1.20 WARRANTY

A. All materials and equipment, to be furnished and installed under this Division of the Specifications shall be warranted to meet the specified performance requirements and to be free of defects in materials and workmanship for a period of one year after final acceptance. The Contractor to the complete satisfaction of the Owner's representative shall remedy deficiencies caused by other than normal usage, without cost to the Owner or Design Professionals.

B. If there is any indication that the equipment does not meet the specified quantities, the Contractor shall, at his expense, institute a program to demonstrate the adequacy of the installation. This program shall include all necessary testing and testing equipment. Should the Contractor not have the equipment or technical skill to perform the tests, it shall be his responsibility to employ recognized experts to perform the tests and shall provide certified laboratory tests, certified factory reports and work sheets, or other certified data to support results of any tests required.

C. Equipment warranties extending beyond the first year warranty generally include material only guarantees except where required by specific reference (i.e. compressors). Owner is responsible for additional expenses and the assembly of adequate record keeping during warranty period.

1.21 BILLINGS

Contractor shall provide a schedule of values of the mechanical work with each payment application. Provide a line item for labor and materials for each section of
specifications. Provide additional breakdown where requested by Owner’s Representative.

PART 2 PRODUCTS

2.1 EQUIPMENT

Coordinate exact electrical requirements of mechanical equipment prior to submittal and purchase. Equipment that is not compatible with electrical installation will be removed and replaced at no expense to the Owner or Design Professionals.

2.2 MATERIALS

A. Unless otherwise specified, provide only new, first grade equipment and materials which comply with requirements of this Specification and applicable Standards.

B. Furnish, if required, satisfactory evidence of kind and quality of materials proposed for use.

C. Similar items of material and equipment shall be product of same manufacturer.

2.3 SUBSTITUTIONS

A. The Specifications indicate a standard of quality for materials. Manufacturer’s names and catalog numbers are used to designate materials or equipment to establish grade and quality. Where several manufacturers are named, the bid shall be based on those named manufacturer's products. Where only one manufacturer is named, unless stated otherwise, manufacturers of equal quality products will be considered as substitutions only if submitted at least 5 days before the bid date and when in compliance with all criteria set forth within Section 2.3:

1. Contractor is responsible for all coordination and additional costs which may be required for the work to be completed on time with no additional cost to the Owner or Design Professionals.

2. Contractor to verify during submittal that the product works dimensionally within the intent of the design.
   a. The ability to service components shall not be compromised.
   b. Any additional coordination due to interference with other elements of the project will be the responsibility of the Contractor with no additional cost to the Owner or Design Professionals.

B. It is fully the Contractor's responsibility to assemble and submit sufficient technical information to fully illustrate that the material or equipment proposed for substitution is equal or superior as the Architect or Engineer is under no obligation to perform the service for the Contractor. The proposal shall be accompanied by manufacturer’s complete engineering data,
specification sheet, and a sample, if practical or if requested. In no event shall a proposal for substitution be cause for delay of work.

C. Substitutions and deviations shall be clearly marked, indicated, or otherwise called to attention of the Owner’s representative in the submittal documents. Failure to indicate substituted materials and/or equipment or deviations from Contract Documents shall be construed as a representation that contractual obligations have not been meet and the submittal shall be rejected without further review.

D. Engineer reserves the right to accept or reject proposed substitutions and it is understood that his judgment shall be final.

2.4 ELECTRICAL MOTORS

A. All motors furnished under any of the several Sections of these Specifications shall be of recognized manufacturer, of adequate capacity for the loads involved, and wound for the electrical characteristics indicated on the Drawings or specified herein. Verify all job site voltages and power source available before installation of any motor or controls. All motors shall conform to the standards of manufacture and performance of the National Electrical Manufacturers Association (NEMA) as shown in their latest publication. All motors shall be furnished with open-frame, unless otherwise noted, or required by NEC for the service conditions encountered.

B. Unless otherwise noted, fractional motors rated at less than 1/2 horsepower shall be single phase, the motors rated at 1/2 horsepower or larger shall be three phase. Single phase motors shall be arranged for across-the-line starting. Motors exposed to weather shall be totally enclosed and weatherproof. Single phase motors shall be capacitor start, induction run type and shall be furnished with motor controller with pilot light where scheduled or indicated.

C. Except as otherwise specified, open motors over one (1) horsepower shall be drip proof, squirrel cage, high efficiency type similar or equal to Reliance XE, Century E Plus III, Baldor Super E or General Electric Energy Saver, NEMA Design B, induction type rated for constant duty with 40 Deg. C. temperature rise. Furnish submittal data on all high efficiency motors furnished to include motor efficiencies as rated in accordance with IEEE Standard 112, Test Method B. Motors under one (1) horsepower shall be same as described herein, but standard efficiency rating.

D. All motors shall be of the same manufacturer unless they are an integral part of the piece of equipment to which they are attached.

2.5 MOTOR CONTROLLERS AND ELECTRIC INTERLOCKS

A. Except where otherwise specified or as included as an integral part of the normal and customary mechanical equipment, each starter shall be furnished by other divisions complete with the required control power transformers and
auxiliary contacts necessary for control interlocks and wired by a licensed electrician in accordance to governing codes.

B. In Fractional horsepower 120v-single phase roof or wall mounted fans, a motor rated manual starter/disconnect with on-off snap switch type with soldered ratchet overload protection shall be furnished by the Contractor furnishing the fans and wired by a licensed electrician in accordance to governing codes.

C. When interlocking of equipment is required all wiring in excess of 50 volts to be provided by a licensed master electrician and coordinated by the Contractor. All other wiring 50 volts or less or as required by the controls/energy management system shall be fully coordinated by the Contractor to provide and assure a complete and fully operational system. All conduit for controls and or power wiring shall be in accordance with Division 16 requirements, and installed by licensed electrician and coordinated by the Contractor.

D. Except for such items that are normally wired up to their point of manufacture and so delivered and unless specifically noted to the contrary herein, the Contractor shall do all electric wiring of every character for interlocking, pilot, and control in accordance with methods and materials described within Division 16 of these Specifications. This includes conduits and mounting of all electrical devices.

E. Furnishing of complete wiring diagrams showing proper control and interlock wiring shall be work under the trade supplying the equipment. Diagrams shall be based on the approved equipment for this project and shall be complete integral drawings, not a series of manufacturers’ individual diagrams.

F. The electrical design and drawings are based on the equipment scheduled and shown on the mechanical Drawings and should any mechanical equipment requiring changes to the electrical design be approved, the required electrical changes shall be made at no cost to the Owner.

2.6 CONTROL POWER AND EQUIPMENT POWER FOR CONTROLS

A. Control power, whether it be DDC, 24 volt, or 120 volt, should be delivered to each piece of mechanical equipment, fire/smoke dampers, and/or control panels whether or not it is specifically indicated on the Contract Drawings.

B. It is the Contractor’s responsibility to include in his or her bid all costs in connection with control wiring, and/or power, whether or not it is specifically indicated. Regardless of how large in nature or how incidental, no additional compensation will be approved by the Owner’s representative or Design Professionals concerning a failure on the Contractor’s part to include these costs in bid proposal or a failure on the Contractor’s part to properly coordinate these important functions.
2.7 SAFETY GUARDS

A. Provide safety guards for moving equipment such as fan belt drives and motor drive couplings.

B. Use OSHA approved belt guards and couplings guards. Provide 1/2 inch hole in guard at center of shaft of driven equipment where belt type drives are used.

2.8 LIFE SAFETIES FIRE SMOKE DAMPERS

A. It is the Contractor’s responsibility to coordinate with the architectural Drawings and verify the need for fire and or fire smoke dampers whether or not they are specifically indicated. Additionally it is the Contractor’s responsibility to include in bid proposal the cost to furnish and install fire and or fire/smoke dampers required by code, whether or not they are specifically indicated.

B. It is the Contractor’s responsibility to coordinate with other applicable trades to determine the proper voltage of the fire/smoke damper operator and the proper sequencing of the damper operation. Refer to paragraph “Electrical Motors” and other Sections of Division 15 and Division 16 for the requirements for the damper operator wiring.

PART 3 EXECUTION

3.1 PRODUCT HANDLING, RECEIVING, INSPECTION, AND STORAGE

A. Handling and Receiving: The Contractor shall receive and handle all materials and equipment with care so as not to cause damage. Use padded or strap slings, etc. as appropriate for the items being handled. Lift materials and equipment by lift points provided or recommended by the manufacturer.

B. Inspection: The Contractor shall upon receipt, inspect all materials and equipment for defects, damage, and compliance with the Specifications. When materials and equipment are received in acceptable condition, assume full responsibility for its storage, handling, and installation. Materials and equipment found to be incomplete or damaged shall be reported to the Carrier and Owner's representative immediately, within a maximum of three (3) days, for its replacement.

C. Identification: Upon receipt of all materials and equipment, the Contractor shall identify and tag, stencil, or otherwise permanently identify all materials and equipment with the appropriate equipment number.

D. Storage: Materials and equipment, which cannot be installed immediately after delivery, shall be stored in a safe, dry location provided by the Contractor. Materials and equipment damaged or stolen while in storage shall be replaced by the Contractor at no cost to the Owner.
3.2 COORDINATION WITH OTHER DIVISIONS AND OWNER

A. General: Cooperate to fullest extent with other Divisions and Owner to the end that all work shall be executed economically without delay and that it will not interfere with their operations.

B. Progress Schedule: Contractor shall inform himself of progress schedules of all Divisions and shall work in accordance with schedules for completion of work.

C. Examine work of other trades that comes in contact with or is covered by this work. Do not attach to, cover, or finish against any defective work, or install work of this Division in a manner which will prevent other trades from properly installing their work. Consult all Drawings, Specifications, and details of other Divisions of the work.

D. Do not install equipment with electrical characteristics that are not compatible with the electrical installation.

3.3 EQUIPMENT ACCESSORY REQUIREMENT

It shall be the Contractor’s responsibility to assure all packaged equipment ancillary devices shall be completely wired, piped, tubed for pneumatics, and calibrated. All systems shall be commissioned for acceptance by the Owner.

3.4 INSTALLATION

A. Space And Equipment Arrangement:
   1. All equipment shall be installed in a manner to permit access to parts requiring service and to comply with code-mandated and manufacturer required clearances. Contractor shall notify Owner’s representative prior to installation of any equipment where said clearances cannot be maintained for further direction.
   2. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly and completely protected from damage as hereinbefore specified.

B. Materials and equipment installed under this Contract shall be new in every respect, and installed in a first-class manner in accordance with the manufacturer’s recommendations and applicable codes and standards.

C. The Contractor shall plan and coordinate his Work to provide all equipment and materials necessary to provide the Owner with a neat, functional, and serviceable installation.

D. The Contractor shall protect all work, materials, and equipment against damage until Final Acceptance by the Owner’s representative. Replace, or
repair to the satisfaction of the Owner’s representative, any work, materials, or equipment that becomes damaged prior to Final Acceptance.

E. The Contractor shall make a detailed inspection of the work area and adjoining construction prior to beginning installation of any materials or equipment. Verify governing dimensions and other permissible dimensional tolerances. The Contractor shall report in writing to the Owner’s representative unsatisfactory conditions encountered; do not begin installation until conditions are correct. Beginning installation signifies acceptance of conditions.

3.5 EXCAVATION AND BACKFILL

A. Prior to any excavation, the Contractor shall have all utilities marked. The Contractor shall perform all excavation of every description required in the execution of his work. Excavation shall be through whatever substance encountered, to the depths indicated on the Drawings, or as required. Contractor shall hand dig wherever necessary to prevent damage to existing utilities. Excavated material suitable for backfill shall be piled in an orderly manner a sufficient distance from the trench to prevent overloading sides and cave-ins. Excavated materials not suitable for backfill shall be removed from the site or stored as directed. Grading shall be done to protect the excavation from surface water. Trenches shall be maintained in a dry condition by bailing, pumping, or other approved methods. Pipe shall not be laid in wet trenches. Sheet and shoring shall be provided as required for the protection of the work and the safety of personnel.

B. Trenches shall be of the necessary width and depth to provide for proper installation of pipe and appurtenances, with banks as nearly vertical as possible. Bottoms of trenches shall be excavated to the grade and depth indicated or required, and barrel of pipe shall be laid on a minimum 12-inch sand bed. Bell holes, of a size to permit proper make-up of grading, shall be provided as required. Existing underground piping shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired to the satisfaction of the Owner’s representative, at the Contractor’s expense. Provide 3,000 pound concrete of 3” minimum enclosure around lines that cross electrical utility lines or telephone cables.

C. Trenches shall not be backfilled until all required tests have been performed. This requirement does not preclude sectional testing and backfilling of the various systems. Trenches shall be carefully backfilled with approved sand, free from large earth clods, rocks, and/or foreign materials, laid in 6” layers, moistened thoroughly, and carefully rammed to an elevation of one foot above top of pipe. The remainder of the backfill to finish grade shall be placed in one-foot layers soaked with water, and well tamped. Under roadways, backfill to bottom of road bed material with sand only. Where settlement occurs, trenches shall be re-opened to depth required for proper compaction, re-filled, and compacted.
D. Open trenches abutting foundation or basement excavations, building walls, and grade beams, will not be permitted, but shall be backfilled and completed, for a distance of not less than 10’ from the above features, as soon as possible. All damage resulting from flooding or other stresses due to open trenches shall be paid for by the Contractor.

E. Where excavation requires, existing walks, street, drives, or other existing pavement to be cut to install new lines and to make new connections to existing lines, the size of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new materials is completed and the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall be thoroughly bound with the original surfaces, and shall be level with them.

F. All excavation shall conform to the laws of the State of Texas.

3.6 CUTTING AND PATCHING

A. This Contractor shall do all necessary cutting and drilling of present walls, floor, ceilings, etc. for the installation of new work or for modifications to the existing work, but no structural work shall be cut unless specifically approved by the Owner's representative. Patching and painting of surfaces as required shall be by the Contractor, unless specified hereinafter.

B. Cutting and patching or repairing of work in place, made necessary by the negligence of the Contractor or anyone employed by him, shall be paid for by the Contractor.

3.7 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities as used by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices and receive written permission from the Owner's representative to enter existing areas. The Contractor before beginning work in existing areas shall make necessary arrangements and perform other services required for the care, protection, and in service maintenance of all electrical, communication, plumbing, heating, air conditioning, and ventilating services for new and existing facilities. The Contractor shall erect temporary barricades with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result to the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, the Contractor shall be responsible for removing doors, piping, air conditioning ductwork, and equipment, etc. to provide this
access and shall reinstall same upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, the Contractor shall remove and reinstall in locations approved by the Owner’s representative all devices required for the operation of the various electrical systems installed in the existing construction. This is to include but is not limited to temperature control system devices, electrical switches, relays, fixtures, piping, conduit, etc.

3.8 OUTAGES

Outages of services as required by the project will be permitted, but only at a time approved by the Owner. The Contractor shall notify the Owner in writing two weeks in advance of the requested outage in order to schedule required outages. No outages shall be taken unless written approval has first been received from the Owner. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.

3.9 CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. The Mechanical Division shall provide all mechanical connections to equipment furnished by other Divisions or the Owner that require service connections and/or ductwork.
   1. The Mechanical Division shall furnish materials and labor required for the connection of equipment except where indicated on Drawings as furnished by others.

B. The respective supplier shall furnish proper roughing-in diagrams for the installation of these items. All items shall be roughed-in and connected in strict accordance therewith.

3.10 INSPECTIONS

Contractor shall arrange for all inspections required by local building officials and state agencies. Correct deficiencies required to comply with codes and standards and to receive certificate of occupancy. Upon completion of this project, submit written evidence of compliance with the above to Owner’s representative. Final acceptance will not be issued and the warranty date will not be established until such compliance is demonstrated.

3.11 SYSTEMS START-UP

A. Upon completion of the installation of the work, start-up all mechanical systems and test, balance and adjust systems until they are fully operational and functioning as intended by Engineer.

B. Do not start-up or operate HVAC systems until construction of building envelope is complete and system components will not be subjected to damage
from dirt, dust, construction debris, and weather. Provide temporary caps on ductwork and piping to prevent entry of debris. Where adequate protection is not provided, all systems shall be cleaned or replaced to the satisfaction of the Owner.

C. Provide factory start-up and commissioning of all rooftop package equipment by a representative employed by the equipment manufacturer. Include copies of the start-up and commissioning reports in the O&M Manuals.

3.12 FINAL CONSTRUCTION REVIEW

A. Schedule: Upon completion of the Contract, there shall be a final construction review of the completed installation. Prior to this walk through, all work under this Division shall have been completed, tested, balanced and adjusted in final operating condition and the test report shall have been submitted to and approved by the Owner's representative.

B. Personnel: A qualified person representing the Contractor must be present at this final construction review to demonstrate the system and prove the performance of the equipment.

C. The building mechanical system shall have been in operation for a minimum of fifteen (15) days after Test and Balance work is complete prior to this review.

3.13 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these Specifications and with manufacturer’s requirements.

B. Certification is specifically required from the following:
   1. Leak test of all renovated and new draining systems.
   2. Pressure test of all renovated and new pressure piping systems.
   3. Sterilization of all renovated and new water piping systems.
   4. Equipment performance tests.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Starting of Plumbing and HVAC Systems.
   B. Commissioning of HVAC Systems.
   C. Demonstration and Instructions.
   D. Testing, Adjusting, and Balancing.

1.2 RELATED SECTIONS
   A. Section 15985 – Sequence of Operation.
   B. Section 15990 – Testing, Adjusting, and Balancing.
   C. All Divisions of Contract Documents.

PART 2 PRODUCTS

   Not Used.

PART 3 EXECUTION

3.1 STARTING OF PLUMBING AND HVAC SYSTEMS
   A. Coordinate schedule for start-up of various equipment and systems.
   B. Notify Owner's representative seven (7) days prior to start-up of each item.
   C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions that may cause damage.
   D. Do not start-up or operate HVAC systems until construction of building envelope is complete and system components will not be subjected to damage from dirt, dust, construction debris, and weather.
   E. Clear dirt, dust, and grout from equipment on exterior of casings, interior surfaces, heat exchangers, heating and cooling coils, burners, and the like, and interior surfaces of ductwork prior to acceptance by Owner.
   F. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
G. Adjust electrical amp draw on motors to within 80% of rated amp draw.

H. Verify wiring and support components for equipment are complete and tested.

I. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturers' instructions.

J. Activate and operate all HVAC equipment and systems and verify that the system is functioning properly in all modes and sequences of operation. When verification is complete, demonstrate all modes and sequences to Owner's representative.

K. Activate and operate all plumbing equipment and systems and verify that all systems are functioning properly in all modes and sequences of operation. When verification is complete, demonstrate all modes and sequences to Owner's representative. Verify hot water temperature settings, relief valve operation, pressure regulator operation, gas regulator operation, tempered water settings, temperature and pressure balancing valve operation, flue damper operation, combustion efficiencies, flush valve operation, and the like.

L. When specified in individual specification sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

M. Adjust return air to maximum 500 fpm at each air unit inlet.

N. Replace drive packages as necessary to achieve design air flows.

O. Submit a written report that equipment or system has been properly installed and is functioning correctly.

P. Provide factory start-up and commissioning of all rooftop package equipment by a representative employed by the equipment manufacturer. Include copies of the start-up and commissioning reports in the O&M Manuals.

3.2 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of plumbing and HVAC equipment and systems to Owner's personnel two (2) weeks prior to date of final inspection.

B. Demonstrate project equipment and provide instruction by a qualified manufacturers' representative who is knowledgeable about the Project.

C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six (6) months.
D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.

E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at equipment location.

F. Prepare and insert additional data in operation and maintenance manuals when need for additional data becomes apparent during instruction.

G. Video record training sessions and provide copy to Owner.

3.3 DEHUMIDIFICATION OF BUILDING

Start-up of cooling systems shall be accomplished in such a manner as to cool and dehumidify the space without the formation of condensation on building surfaces and elements, furniture, equipment, or appurtenances. Precautions should be taken by the Contractor not to allow excessive humidity to develop in the building prior to final connection and activation of the HVAC system. Should it become necessary, the Contractor shall procure the required equipment to properly dry and dehumidify the space so as not to force the HVAC to perform beyond its intended ability. Should damage occur due to start-up procedures, Contractor shall be responsible for all costs associated with repair or replacement of damaged elements.

3.4 HVAC TESTING, ADJUSTING, AND BALANCING

A. Mechanical Division will secure the services of an independent firm to perform testing, adjusting, and balancing as specified in Section 15990 – Testing, Adjusting, and Balancing. Submit firm selected to Engineer within two (2) weeks after notice to proceed.

B. The Contractor or the independent firm will perform services specified in Section 15990 – Testing, Adjusting, and Balancing.

C. Reports will be submitted by the testing agency to the Owner’s representative indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

D. Contractor shall provide a technician as required by the Test, Adjust and Balance Contractor to assist in correcting issues arising/discovered during any phase of the Test, Adjust and Balance service.

3.5 COMMISSIONING OF HVAC SYSTEMS

Upon completion of the HVAC installation, Contractor shall test, balance, adjust, and operate all individual components of the HVAC system. Demonstrate that the installation is functioning in all modes of operation as a complete and integrated HVAC system and is performing in accordance with the Contract Documents.
Owner's personnel shall be trained in the operation and maintenance of the system. All operating schedules, parameters, and set-points shall be entered into the Facility Management System.

END OF SECTION
SECTION 15058
ACCESS DOORS

PART 1 GENERAL

1.1 WORK INCLUDED

Furnish and install access doors in wall or ceiling locations as required or shown for access to valves, controls, regulating devices, fire dampers, air distribution devices and other equipment requiring maintenance, adjustment or operation.

PART 2 PRODUCTS

2.1 NON-FIRE RATED ACCESS DOORS

Furnish Inryco/Milcor, Acudor, Elmdor, or equal with 16 gauge frames, 14-gauge panels and 22-gauge casing head. Provide continuous concealed hinges and flush screwdriver cam lock. Use Style K access doors for plastered surfaces, Style M for masonry or gypboard surfaces. Use Style AP for acoustical plaster ceiling, with 18-gauge panel and all-galvanized construction.

2.2 FIRE RATED ACCESS DOORS

Furnish Inryco/Milcor, Acudor, Elmdor, or equal, UL listed, 1-1/2 hour Label “B”, access doors with 16-gauge steel frames, and 20-gauge insulated sandwich-type door panel. Provide door with continuous concealed hinge and automatic closing and latching mechanism.

2.3 FINISHED AREAS

Provide stainless steel access doors where located in finished areas that are accessible to the general public such as Toilet Rooms, Offices, and Corridors.

PART 3 EXECUTION

3.1 Access doors specified in Division 15 will be installed by other Divisions. Not all required access doors are shown. Coordinate with the Contractor to locate access doors for ease of operation and maintenance of concealed equipment.

3.2 Installation shall be in accordance with the manufacturer’s printed instructions.

END OF SECTION
SECTION 15060
HANGERS, SUPPORTS, AND FOUNDATIONS

PART 1  GENERAL

1.1  SUMMARY

Section includes pipe and equipment supports, hangers, flashings, curbs, equipment bases, foundations, sleeves, and sealing of work to adjacent construction.

1.2  SUBMITTALS

A.  Section 15010 – Mechanical General Conditions: Submittals.

B.  Shop Drawings: Indicate system layout with location and detail of trapeze hangers where utilized.

C.  Product Data: Submit manufacturers catalog data including load capacity.

D.  Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers where utilized.

E.  Manufacturer's Installation Instructions: Submit special procedures and assembly of components.

1.3  QUALITY ASSURANCE

A.  Perform work in accordance with code for piping support and in conformance with NFPA 13 and 14 for support of sprinkler piping and standpipes.

B.  Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

PART 2  PRODUCTS

2.1  PIPE HANGERS AND SUPPORTS

A.  Manufacturers:

1.  Elcen.
4.  Sioux Chief.
5.  ITT Grinnell.
7.  Substitutions: Section 15010 – Mechanical General Conditions.

B.  Plumbing Piping – DWV and Storm Drainage:

1.  Conform to ASME B31.9 ASTM F708.
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 Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 inches: Pipe clamps and channel bracing secured to wall framing.
6. Wall Support for Pipe Sizes to 4 inches and over: Welded steel bracket and wrought steel 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 adjustable, ring.

C. Plumbing Piping - Water:
1. Conform to ASME B31.9 ASTM F708.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Wall Support for Pipe Sizes to 3 inches: Pipe clamps and channel bracing secured to wall framing.
7. Wall Support for Pipe Sizes 4 inches and over: Welded steel bracket and wrought steel clamp.
9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
10. Floor Support for Hot Pipe Sizes to 4 inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
11. Copper Pipe Support: Copper-plated, carbon-steel ring.
12. Copper Piping Concealed in Stud Walls: Copper plated stud brackets.

D. Condensate Drain Piping:
1. Conform to ASME B31.9 ASTM F708.
2. Roof Piping Supports: Miro Industries or equal, refer to Drawings.
3. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.
4. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
5. Wall Support for Pipe Sizes to 3 inches: Pipe clamps and channel bracing secured to wall framing.
6. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.
7. Piping Concealed in Stud Walls: Galvanized steel or copper plated stud brackets.
E. Fire Protection Piping:
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 Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
8. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

2.2 ACCESSORIES

Hanger Rods: Hot dipped galvanized mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 PROTECTION OF HANGERS

A. Steel hangers, hanger rod and appurtenances located in crawl spaces, ventilated mechanical rooms, unconditioned attics or exposed to outdoors shall be hot dipped galvanized.
1. As an alternate method, components such as rollers, chairs, pipe stands, steel supports, etc., may be primed with PPG or equal Inhibitor Red Primer 6-208, and painted with two (2) coats of PPG or equal Enamel 54 Line.
2. All surfaces to be painted shall be free of dust, rust, scale, grease, or other foreign material, and shall be dry at time of painting.

2.4 INSERTS

A. Manufacturers:
1. ITT Grinnell.
3. Elcen.
5. Substitutions: Section 15010 – Mechanical General Conditions.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflash: 22 gage thick galvanized steel.
C. Lead Flashing:
   1. Waterproofing: 5 lb./sq. ft sheet lead.
   2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22-gage minimum; 16 gage at fire resistant elements.

F. Plumbing Vents Through Roof (VTR): Refer to Part 3 Execution, Flashing.

2.6 EQUIPMENT CURBS

A. Manufacturers:
   1. RPS Corporation.
   2. Pate.
   4. Thy Curb.
   5. Substitutions: Section 15010 – Mechanical General Conditions.

B. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, 1-1/2 inch thick insulation, factory installed wood nailer. Curb shall be 14 inches minimum above roofing surface. Construct to match pitch of roof.

C. Curbs to be constructed of materials that are dielectrically compatible with roof deck. Contractor to verify of curb and roof deck prior to submittal.

D. Refer to other sections of these Specifications for additional requirements or special requirements suitable for that section's application, i.e. Packaged Rooftop Units.

2.7 SLEEVES

A. Manufacturers:
   1. Pro Set.
   2. Substitutions: Section 15010 – Mechanical General Conditions.

B. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

C. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

D. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

E. Sleeves for Round Ductwork: Galvanized steel.

F. Sleeves for Rectangular Ductwork: Galvanized steel.

G. Stuffing or Fire-stopping Insulation: Glass fiber type, non-combustible.
H. Sealant: Acrylic in non-fire rated application.

I. Where approved by Engineer prior to installation, at floor penetration of slab on grade construction, flexible foam pipe wrap such as “Flex-Wrap” by Cal-Western may be substituted for sleeve.

J. Cover trap primer piping embedded in concrete floors and walls with “Poly-Sleeve” or equal polyethylene sleeve material.

2.8 FIRE STOP SYSTEMS

A. Manufacturers:
   1. 3m Model 2000.
   2. Spec Seal Model 100.
   3. Hilti.
   4. Substitutions: Section 15010 – Mechanical General Conditions.

B. General Purpose Fire Stopping Sealant: Water based non-slumping, premixed sealant with intumescent properties, rated for 3 hours in accordance with ASTM E814 and UL 1479.

C. General Purpose Vibration Resistant Fire Stopping Sealant: Silicone based, non-slumping, premixed sealant with intumescent properties, vibration and moisture resistant, rated for 3 hours in accordance with ASTM E814 and UL 1479.

D. Plastic Pipe Systems Fire Stopping Sealant: Silicone based, premixed sealant with intumescent properties, vibration and moisture resistant, rated for 3 hours in accordance with ASTM E814 and UL 1479 with metal collars.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install cast iron piping in accordance with CISPI Standards.

3.2 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 over 4 inches.

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 recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

A. Piping systems shall be installed so as to be freely floating. They shall be securely supported from structure but shall be able to expand and contract independently of structure without causing undue stress or damage to the piping system. Piping shall not support itself. Piping systems shall be rigidly attached to structure only where shown on plans, as required by Specifications and codes, or as required for proper installation of equipment or fixtures. Provide sleeves, rollers, expansion fittings, expansion loops, or special fittings as required to prevent transmission or vibration to the structure or for the proper operation of systems whether specifically shown on plans or not.

B. Install in accordance with ASME B31.9, ASTM708.

C. Support horizontal piping as scheduled.

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 horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

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. Support base of risers in crawl spaces or above ceilings with braces, blocks, rodding or other suitable method, to prevent movement of pipe or separation of joints and fittings.

M. Provide non-conducting dielectric connections wherever dissimilar metals come in contact such as between pipe and hangers or pipe and metal structure and wall studs.

N. Paint pipe and equipment supports exposed to weather with galvanizing paint or other approved method.
O. Where piping is suspended in excess of 18 inches, provide sway bracing to secure against horizontal movement.

P. Install hangers adjacent to motor driven equipment with vibration isolation; refer to Section 15070 – Mechanical Vibration Isolation.

3.4 EQUIPMENT BASES, FOUNDATIONS, SUPPORTS, AND ATTACHMENTS

Provide necessary foundations, supports, pads and equipment bases as required and shown on Drawings or as required by manufacturer for equipment furnished by Mechanical Division. Materials, fixtures, and equipment shall be securely attached to the building structure. Attachments shall be strong, durable, and suitable for their intended application.

A. Provide housekeeping pads or foundations for every item of floor mounted equipment specified herein or indicated on the Drawings.

B. All concrete foundations required by equipment furnished by the Mechanical Division shall be constructed by the Mechanical Division (except where otherwise noted) in conformity with the recommendations of the manufacturer of the respective equipment and with the approval of the Owner's Representative.

C. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment. Steel members may be substituted for concrete pad where approved prior to installation, or as shown on Drawings.

D. All corners of the foundations shall be neatly chamfered at a 45 degree angle.

E. After removal of the forms, the surface of the foundation shall be hand rubbed.

F. All concrete work performed by the Contractor shall conform entirely to the requirements of the General Specifications which describe this class of work.

G. Provide additional steel framing to raise equipment above housekeeping pad where necessary to properly construct p-traps and equipment drains.

H. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

3.5 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 10 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 12 inches minimum clear
on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal. At metal roofs, provide dielectrically compatible flashing.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor and mop sink drains watertight to adjacent materials.

E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.

F. Provide curbs for mechanical roof installations 14 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

G. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 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 2 inches above finished floor level. Caulk sleeves.

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

E. Install chrome plated steel escutcheons at finished surfaces.

3.7 SCHEDULES

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<th>MAX. HANGER SPACING</th>
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END OF SECTION
SECTION 15070
MECHANICAL VIBRATION ISOLATION

PART 1 GENERAL

1.1 SUMMARY
Section includes vibration isolation and ductwork lagging.

1.2 PERFORMANCE REQUIREMENTS
A. Provide vibration isolation on motor driven equipment over 0.5 hp, and connected piping and ductwork.

B. Provide minimum static deflection of isolators for equipment as follows:
   1. Under 400 rpm: As recommended by manufacturer.
   2. 400 - 600 rpm: 3.5 inch.
   3. 600 - 800 rpm: 2 inch.
   4. 800 - 900 rpm: 1 inch.
   5. 1100 - 1500 rpm: 0.5 inch.
   6. Over 1500 rpm: 0.2 inch.

1.3 SUBMITTALS
A. Section 15010 – Mechanical General Conditions: Submittal procedures.

B. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

C. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions.

1.4 CLOSEOUT SUBMITTALS
Project Record Documents: Record actual locations of ductwork lagging. Record actual locations of hangers including attachment points.

1.5 QUALITY ASSURANCE
Perform work in accordance with AMCA 300, ANSI S1.13, ARI 575, ASA 16 (ANSI S1.36) standards and recommendations of ASHRAE 68.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS
A. Manufacturers:
   1. Amber Booth.
2. Mason Industries.
4. Substitutions: Section 15010 – Mechanical General Conditions.

B. Closed Spring Isolators:
1. Spring Isolators:
   a. For Interior areas: Provide aluminum housings and plastic coated springs. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with telescoping top and bottom housing separated with neoprene rubber stabilizers to limit horizontal motion. Provide elastomeric pad of minimum ¼” thickness bonded to the bottom of the base plate.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
5. Amber Booth Type XL, XLS or equal.

C. Spring Hanger:
1. Spring Isolators:
   a. Provide hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
5. Amber Booth Type BSSR or equal.

D. Neoprene Pad Isolators:
1. Rubber or neoprene-waffle pads.
   a. 30 durometer.
   b. Minimum ½ inch thick.
   c. Maximum loading 40 psi.
   d. Height of ribs: not to exceed 0.7 times width.
2. Configuration: ½ inch thick waffle pads bonded each side of ¼ inch thick steel plate.
3. Amber Booth Type SP-NRE or equal.

E. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

2.2 DUCTWORK LAGGING

A. Acoustic Insulation: 2 inch thick, 3 to 5 lb/cu ft. density glass fiber insulation.
B. Covering: Sheet lead or gypsum board with surface weight minimum 4 lb/sq ft.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturers’ instructions.

B. Lag ductwork, where indicated, by wrapping with insulation and covering. Apply covering to be airtight. Do not attach covering rigidly to ductwork.

C. Install isolation for motor driven equipment.
   1. Bases:
      a. Set steel bases for 1 inch clearance between housekeeping pad and base.
      b. Adjust equipment level.

D. Install spring hangers without binding.

E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

G. Connect wiring to isolated equipment with flexible hanging loop.

3.2 MANUFACTURER’S FIELD SERVICES

Inspect isolated equipment after installation and submit report. Include static deflections.

3.3 SCHEDULES

PIPE ISOLATION SCHEDULE

<table>
<thead>
<tr>
<th>Pipe Size Inch</th>
<th>Isolated Distance from Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>120 diameters</td>
</tr>
<tr>
<td>2</td>
<td>90 diameters</td>
</tr>
<tr>
<td>3</td>
<td>80 diameters</td>
</tr>
<tr>
<td>4</td>
<td>75 diameters</td>
</tr>
<tr>
<td>6</td>
<td>60 diameters</td>
</tr>
</tbody>
</table>
### EQUIPMENT ISOLATION SCHEDULE

<table>
<thead>
<tr>
<th>ISOLATED EQUIPMENT</th>
<th>Isolation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Exhaust Fans</td>
<td>Spring Hanger or Rubber Mount Hanger</td>
</tr>
<tr>
<td>VAV Terminal Units</td>
<td>Spring Hanger</td>
</tr>
<tr>
<td>Packaged Rooftop Units</td>
<td>Vibration Isolation Curb</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 15075
MECHANICAL IDENTIFICATION

PART 1  GENERAL

1.1 SUMMARY
Section includes nameplates, tags, stencils, and pipe markers.

1.2 SUBMITTALS
Section 15010 – Mechanical General Conditions: Submittal procedures.

1.3 CLOSEOUT SUBMITTALS
Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.4 QUALITY ASSURANCE
A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, UL 723.
B. Refer and conform to NFPA 99 requirements for labeling and identification of piping systems and accessories.
C. Refer and conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
D. Maintain one (1) copy of each document on site.

1.5 QUALIFICATIONS
Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

PART 2  PRODUCTS

2.1 NAMEPLATES
A. Manufacturers:
1. Brady.
2. Seton.
3. LEM.
4. Substitutions: Section 15010 – Mechanical General Conditions.

B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 CEILING TACKS
A. Manufacturers:
1. Brady.
2. LEM.
4. Substitutions: Section 15010 – Mechanical General Conditions.

B. Description: Steel with 3/4-inch diameter color-coded head or adhesive backed colored paper.

C. Color code as follows:
   1. HVAC Equipment: Yellow.
   2. Fire dampers / smoke dampers: Red
   3. Plumbing valves: Blue.

PART 3 EXECUTION

3.1 PREPARATION

Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

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

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

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.

D. Identify packaged rooftop units, variable volume terminal units, fans, variable frequency drives and other mechanical equipment with plastic nameplates. Air devices do not require mechanical identification.

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

F. Tag automatic controls, instruments, and relays. Key to control schematic.

G. Identify piping, concealed or exposed, with plastic pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed twenty (20) 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.

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

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

END OF SECTION
SECTION 15080
MECHANICAL INSULATION

PART 1 GENERAL

1.1 SUMMARY

Section includes ductwork insulation, duct liner, insulation jackets, equipment insulation, covering, thermal insulation for piping systems including vapor retarders, jackets, and accessories.

1.2 SUBMITTALS

A. Section 15010 - Mechanical General Conditions: Submittals.

B. Product Data: Submit product description, thermal characteristics, and list of materials and thickness for each service, and location.

1.3 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

B. Applicator: Company specializing in performing work of this Section whose primary business is insulation with minimum three (3) years documented experience.

1.4 QUALITY ASSURANCE

Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, UL 723.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

B. Maintain temperature during and after installation for minimum period of 24 hours.
1.7 REGULATORY COMPLIANCE


PART 2 PRODUCTS

2.1 GLASS FIBER, FLEXIBLE

Insulation for exterior of sheet metal ducts, backside of diffusers, storm drainage piping, and bottom side of roof drain bodies.

A. Manufacturers:
   2. Knauf Model Ductwrap.
   3. Owens Corning.

B. Insulation: ASTM C553 Glass Fiber Blanket Thermal Insulation for Commercial and Industrial Applications, Type II.
   1. K Value: ASTM 518, 0.29 at 75 degrees F.
   2. Maximum Service Temperature: ASTM C411, 250 degrees F.
   3. Maximum Moisture Absorption: ASTM C1104, 0.2 percent by volume.
   4. Moisture Vapor Transmission: ASTM E96, 0.02 perm.
   5. Density: 0.75 or 1.0 pounds per cubic foot.

C. Vapor Retarder Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film ASTM C1136, Type II.
   2. Moisture vapor transmission: ASTM E96; 0.02 perm.
   3. Secure with outward clinching staples and pressure sensitive tape.

D. Vapor Retarder Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Installation: Maximum allowable compression is 25 percent.

2.2 GLASS FIBER, RIGID - Insulation for exterior of sheet metal ducts.

A. Manufacturers:
   2. Knauf Model Insulation Board.

B. Insulation: ASTM C612 Mineral Fiber Block and Board Insulation, Type IA
   1. K Value: ASTM 518, 0.23 at 75 degrees F.
   4. Moisture Vapor Transmission: ASTM E96, 0.02 perm.
   5. Density: 3.0 pounds per cubic foot.

C. Vapor Retarder Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film ASTM C1136.
2. Moisture vapor transmission: ASTM E96; 0.04 perm.
3. Secure with speed washers. Seal all joints, breaks, punctures, or protuberances with pressure sensitive tape.

D. Vapor Retarder Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Indoor Vapor Retarder Finish:
1. Cloth: Untreated; 1.6oz/sq yd weight, glass fabric.
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.3 POLYISOCYANURATE FOAM - For Piping or Use as Inserts

A. Manufacturer: Dow Trymer 2000.

B. Insulation: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
1. K Value: ASTM 518; Initial – 0.14 at 75 degrees F.; Aged 180 days – 0.19 at 75 degrees F.
2. Minimum Service Temperature: -250 degrees F.
3. Maximum Service Temperature: 300 degrees F.
7. Vapor seal seams with suitable mastic.
8. Minimum R-Value: Refer to Part 3 Schedules.

C. Vapor Barrier Jacket:
1. ASTM C921, Factory applied, all service jacket, white kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
3. Secure with self-sealing longitudinal laps and butt strips, then with outward clinch expanding staples and vapor barrier finish.

D. Fittings:
1. Material and thickness to be same as adjacent pipe. Fittings to be mitered with a minimum of 3 miters per fitting. Secure with glass fabric and mastic and cover with PVC fitting covers. Vapor seal seams with suitable mastic.
2. All joint and fitting fabrication work to be out in accordance with ASTM C-585 and C-450.

E. Tie Wire: 16 gage stainless steel with twisted ends on maximum 12 inch centers. In mechanical rooms, cover wire with ASJ tape.
F. Vapor Barrier Lap Adhesive:
   1. Self sealing by manufacturer.
   2. Compatible with insulation.
   3. Provide additional vapor seal by coating lap with Foster 30-35.

G. Fibrous Glass Fabric:
   1. Manufacturers:
      a. Childers #10 CHILL-GLAS.
      b. Fosters MAST-A-FAB.
   2. Cloth: Untreated: 1.6oz/sq yd weight.

H. Indoor Vapor Barrier Finish:
   1. Manufacturers:
      b. Fosters 30-35.
   2. Vinyl emulsion type acrylic, compatible with insulation, white color.

I. Outdoor Vapor Barrier Finish:
   2. Vinyl emulsion type acrylic, compatible with insulation, white color.

J. Insulating Cement:
   1. Manufacturers: Newell PRO-TEC KOTES Model 1MWP.
   2. ASTM C449.

K. Inserts: Provide inserts at hangers on pipe sizes 8 inches and larger.

L. May be used for inserts in piping installed indoors where insulation thickness is 1 inch or less flame/smoke developed rating 25/50; 1 1/2 inches and over – 25/100.

2.4 GLASS FIBER, RIGID - For Piping

A. Manufacturers:
   1. Johns Manville Model Microlok.
   2. Knauf Model 850 ASJ-SSL.
   3. Owens Corning Model ASJ-SSL-II.

B. Insulation: ASTM C612; rigid, noncombustible.
   1. K Value: ASTM C177 or ASTM C518, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.1 percent by volume.

C. Vapor Barrier Jacket:
   1. ASTM C921, Factory applied all service jacket, white kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
   3. Secure with self-sealing longitudinal laps and butt strips, then with outward clinch expanding staples and vapor barrier finish.
D. Fittings: Material and thickness to be same as adjacent pipe. Fittings to be mitered with a minimum of 3 miters per fitting. Secure with glass fabric and mastic and cover with PVC fitting covers. Vapor seal seams with suitable mastic.

E. Vapor Barrier Lap Adhesive:
1. Self sealing by manufacturer.
2. Compatible with insulation.
3. Provide additional vapor seal by coating lap with Foster 30-35.

F. Fibrous Glass Fabric:
1. Manufacturers:
   a. Childers #10 CHILL-GLAS.
   b. Fosters MAST-A-FAB.
2. Cloth: Untreated; 9-oz/sq yd (305-g/sq m) weight.

G. Indoor Vapor Barrier Finish:
1. Manufacturers:
   b. Fosters 30-35.
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

H. Outdoor Vapor Barrier Finish:
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

I. Insulating Cement:
1. Manufacturers:
   a. Newell PRO-TEC KOTES Model 1MWP.
   b. ASTM C449.

J. Inserts: Provide inserts at all hangers for all pipe sizes.

2.5 CELLULAR GLASS - For Use as Insert

A. Manufacturer: Pittsburg Corning Model Foam Glas.

B. Insulation: ASTM C552, Type II – pipe and tubing insulation, Class 2 - Jacketed.
1. K Value: ASTM C177 or ASTM C518, 0.33 at 75 degrees F.
2. Density: 8.0 pounds per cubic foot.

2.6 HYDROUS CALCIUM SILICATE - For Use as Inserts on Hot Water Piping

A. Manufacturer: Johns Manville Model Thermo Gold 12.

B. Calcium Silicate Block and Pipe Thermal Insulation: ASTM C533, Type I Asbestos – free – for use on surfaces up to 1200 F.
1. K Value: ASTM C177 or ASTM C518, 0.42 at 300 degrees F.
2. Maximum Service Temperature: 1200 degrees F.

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.

2.7 ELASTOMERIC CELLULAR FOAM - For Piping or Equipment

A. Manufacturer: Armstrong Model AP Armaflex.

B. Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular form: ASTM C534; Type I, Tubular form. CFC, HCFC, HFC free.
   1. K Value: ASTM C177 or ASTM C518, 0.27 at 75 degrees F.
   2. Minimum Service Temperature: -70 degrees F.
   3. Maximum Service Temperature: +220 degrees F.
      a. 3/4 inch thickness and less: Flame Spread – 25, Smoke Developed – 50.
      a. 3/4 inch thickness and less: Flame Spread – 25, Smoke Developed – 50.
   6. Water Vapor Permeability: ASTM E-96-90, 0.10 perm-in.
   7. Minimum R-Value: Refer to Part 3 Schedules.

C. Elastomeric Foam Adhesive:
   1. Manufacturers:
      a. Armstrong Model 520.
      b. Substitutions: Section 15010 - Mechanical General Conditions.
   2. Air dried, contact adhesive, compatible with insulation.

D. Insulation Tape: Elastomeric foam tape of same material as insulation.

E. Insert Material: Compression resistant elastomeric foam material.

2.8 GLASS FIBER DUCT ACOUSTICAL LINER, FLEXIBLE - Attenuation Insulation for Interior of Sheet Metal Ducts

A. Manufacturers:
   2. Knauf.
   3. Owens Corning Aeroflex Plus.

B. Insulation: ASTM C1071 Type I flexible, noncombustible blanket.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 250 degrees F.
   3. Density: Minimum 2.0 lb/cu ft.
4. Noise Reduction Criteria: 0.90.
5. Maximum Velocity on Coated Air Side: 6,000 ft/min.
6. Minimum Thickness and/or R-Value: Refer to Part 3 Schedules.

C. Adhesive:
1. Manufacturers:
   a. Foster Model 81-90.
   b. Minnesota Mining Model EC104.
   c. Substitutions: Section 15010 - Mechanical General Conditions.
2. Waterproof, ASTM E162 fire-retardant type.

D. Biocide: Coat liner with EPA-registered anti-microbial agent that will not support the growth of fungus or bacteria.


2.9 GLASS FIBER DUCT LINER, FLEXIBLE - Insulation for Interior of Sheet Metal Ducts

A. Manufacturers:
1. Johns Manville Model Permacoat Linacoustic HP.
2. Knauf.
3. Owens Corning.

B. Insulation: ASTM C1071 Type I flexible, noncombustible blanket.
1. K Value: ASTM C177, 0.25 at 75 degrees F.
2. Maximum service temperature: 250 degrees F.
3. Density: Minimum 1.50 lb/cu ft.
4. Noise Reduction Criteria: 0.60 for 1 inch, 0.75 for 1 1/2 inch, 0.85 for 2 inch thickness.
5. Maximum Velocity on Coated Air Side: 6,000 ft/min.
6. Minimum R-Value: Refer to Part 3 Schedules.

C. Adhesive:
1. Manufacturers:
   a. Foster Model 81-90.
   b. Minnesota Mining Model EC104.
   c. Substitutions: Section 15010 - Mechanical General Conditions.
2. Waterproof, ASTM E162 fire-retardant type.

D. Biocide: Coat liner with EPA-registered anti-microbial agent that will not support the growth of fungus or bacteria.


2.10 GLASS FIBER ROUND DUCT LINER

A. Manufacturers:
2. CertainTeed ToughGard Ultra Round.
B. Insulation: Round, preformed in cylindrical sections with acrylic polymer meeting ASTM G21 impregnated surface coat.
   1. K Value: ASTM C1071, 0.23 at 75 degrees F.
   2. Maximum service temperature: 250 degrees F.
   3. Maximum Velocity on Coated Air Side: 6,000 ft/min.
   4. Minimum R-Value: Refer to Part 3 Schedules.

C. Biocide: Coat liner with EPA-registered anti-microbial agent that will not support the growth of fungus or bacteria.

2.11 GLASS FIBER DUCT LINER, RIGID BOARD - Insulation for Interior of Plenums

A. Manufacturers:
   1. CertainTeed ToughGard Rigid Liner Board.
   2. Knauf.
   3. Owens Corning.

B. Insulation: ASTM C1071 Type II Rigid, non-combustible board.
   1. K Value: ASTM C177, 0.23 at 75 degrees F.
   2. Maximum service temperature: 250 degrees F.
   3. Density: 3.00 lb/cu. ft.
   4. Noise Reduction Criteria: 0.70 at 1 inch, 0.80 at 1 1/2 inch, 0.95 at 2 inch thickness.
   5. Maximum Velocity on Coated Air Side: 6000 fpm.

C. Adhesive:
   1. Manufacturers:
      a. Foster Model 81-90.
      b. Minnesota Mining Model EC104.
      c. Substitutions: Section 15010 - Mechanical General Conditions.
   2. Waterproof, ASTM E162 fire-retardant type.

D. Biocide: Coat liner with EPA-registered anti-microbial agent that will not support the growth of fungus or bacteria.


2.12 FIREBLANKET INSULATION

A. Manufacturers:
   1. Partak Insulation, Inc.
   2. Thermal Ceramics Firemaster.
   3. 3M Firemaster.

B. Fireblanket Insulation: Non-asbestos, ceramic fiber blanket, 1 1/2 inch thick, 2 hour fire resistive rating suitable for use on grease hood systems. UL Classified R 14229, CAJ7009, CAJ7013, CAJ7015, CAJ7020, CAJ7022.
2.13 PLENUM WRAP

A. Manufacturer: 3M 5A.

B. Wrap non-metallic piping located in return air plenums with thickness as required by code.

2.14 JACKETS

A. PVC Plastic: Fittings in all locations, piping inside Mechanical Equipment Rooms (AHU, Water Heater Rooms), and where exposed to view in finished spaces:
   1. Manufacturers:
      a. Proto Corporation Model Lo Smoke.
      b. Owens Corning Model Zeston.
      c. Owens Corning Model Ceel-Co.
   2. Jacket: ASTM C921, One-piece molded type fitting covers and sheet material, off white color, factory applied coloring to identify individual services.
      a. Minimum Service Temperature: -40 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
      d. Maximum Flame Spread: ASTM E84; 25.
      e. Maximum Smoke Developed: ASTM E84; 50.
      f. Thickness: 20 mil.
      g. Connections: As recommended by manufacturer.
   3. Covering Adhesive Mastic: Manufacturers:
      b. Compatible with insulation.

   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   4. Fittings: 0.24 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 1/2 inch wide; 0.015 inch thick aluminum.

C. Asphalt Impregnated Sheathing – Underground Valves and Piping.
   1. Asphalt Impregnated Sheathing, 50 mil thickness:
      a. Manufacturers:
         1) Polyguard Insul-wrap 50.
         2) Serva-Wrap.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify piping, equipment, and ductwork have been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with NAIMA National Insulation Standards and Manufacturers instructions.

B. Insure that an effective insulation and vapor seal is achieved on all cold surfaces which will eliminate any sweating or condensation on any cold surfaces installed by the contractor.

C. Exposed Piping: Locate insulation and cover seams in least visible locations.

D. For hot piping conveying fluids over 140 degrees F., insulate flanges and unions at equipment.

E. Insulated Pipes Conveying Fluids Above Ambient Temperature: Insulate entire piping system including fittings, valves, unions, flanges, strainers, flexible connections, expansion joints, air separators, suction diffusers, expansion tanks and chemical feeders:
   1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples and pressure sensitive adhesive system on standard factory-applied jacket and butt strips.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe or as specified in Part 3 Schedules. Finish with glass cloth and adhesive or PVC fitting covers.

F. Underground Valves: Insulate valve body and flanges and cover installation with asphalt impregnated jacket.

G. Equipment Connections: Seal duct and piping at point of connection to equipment to maintain vapor barrier.

H. Inserts and Shields:
   1. Application: Piping or Equipment 1 1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts. Length shall be 4 inches shorter than insert to allow for vapor retarding butt joints.
   3. Insert location: Between support shield and piping and under finish jacket.
   4. Insert configuration: 12 inches long for pipe sizes 1 1/2 to 6 inch, 16 inches for pipe sizes 8 and 10 inch and 22 inches for pipe sizes 12 inch and larger. Thickness and contour to match adjoining insulation; may be factory fabricated.
   5. Insert material: Cellular glass or Calcium Silicate material. Where Elastomeric Foam material is used, provide compression resistant insulating material furnished by insulation manufacturer and suitable for planned temperature range and service.
I. Elastomeric Cellular Foam Insulation – Piping:
   1. Apply adhesive at butt ends of joints and fittings.
   2. Fittings shall be mitered or template-cut in accordance with manufacturer’s instructions. Do not slide tubing over 90 degree elbows.
   3. Inserts: Provide rigid elastomeric insulation at pipe hangers for pipe sizes 1 1/2 inch and larger to prevent compression of insulation.

J. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one (1) hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to architectural for penetrations of assemblies with fire resistance rating greater than one hour.

K. Exterior Applications: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o’clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal equipment.
   1. Elastomeric Insulation – Apply two (2) coats of ultraviolet resistant paint.

L. Domestic Cold Water – Where piping rises up form below grade and enters building, cover entrance riser with insulation and aluminum jacketing.

M. Sanitary Waste Piping and Drains receiving HVAC Condensate: Insulate drain body, p-trap, and waste piping between drain and first major sanitary branch.

N. Sanitary Waste Piping receiving Chilled Drinking Water: Insulate p-trap and waste piping between drain and first major sanitary branch.

O. Factory Insulated Equipment: Do not insulate, except when indicated on Drawings, or other sections of Specifications.

P. Exposed Equipment: Locate insulation and cover seams in least visible locations.

Q. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

R. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

S. Insulated Equipment Containing Fluids Below Ambient Temperature: Insulate entire system.
T. For hot equipment containing fluids over 140 degrees F., Insulate flanges and unions with removable sections and jackets.

U. Finish insulation at supports, protrusions, and interruptions.

V. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

W. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

X. 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, expansion joints, diffuser plenums, and return plenums.
   5. Seal insulation airtight where duct hanger straps penetrate insulation vapor barrier.

Y. Duct and Plenum Liner Application:
   1. Adhere insulation with adhesive for 100 percent coverage.
   2. Secure insulation with mechanical liner fasteners. SMACNA Standards for spacing.
   4. Seal liner surface penetrations with adhesive.
   5. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

Z. Install according to manufacturer’s recommended stretch out chart and to manufacturer’s installation instructions where more stringent than herein.

3.3 SCHEDULES

Provide minimum thickness or R-value as follows. Increase as necessary for compliance with local code. R-values are installed values.

A. Plumbing Systems:
   1. Domestic Hot Water Supply, Domestic Hot Water Re-circulation, Tempered Water Supply, Tempered Water Re-circulation:
      a. Rigid Glass Fiber Insulation:
         1) Pipe Size Range: All sizes.
         2) Thickness: 1 inch.
      b. Elastomeric Cellular Foam:
         1) Pipe Size Range: All sizes.
         2) Thickness: 1 inch.
   2. Domestic Cold Water:
      a. Rigid Glass Fiber Insulation:
1) All piping located outside of building envelope insulation; all piping in exterior walls (regardless of
building insulation envelope); water entrance riser.
  2) Thickness: 1 inch.

b. Elastomeric Cellular Foam:
  1) All piping located outside of building envelope insulation; all piping in exterior walls (regardless of
building insulation envelope); water entrance riser.
  2) Thickness: 1 inch.

3. Drains and waste piping receiving HVAC condensate and chilled drinking water (refer to 3.2):
   a. Elastomeric Cellular Foam:
      1) Pipe Size Range: All sizes.
      2) Thickness: 3/4 inch.
   b. Flexible Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
      2) Thickness: 1 1/2 inch.

4. Roof Drain Bodies:
   a. Flexible Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
      2) Thickness: 2 inch.

5. Roof Drainage Piping Run Horizontal in Ceiling Space at Roof and Vertical Riser to Roof Drain Body:
   a. Flexible Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
      2) Thickness: 1 1/2 inch.
   b. Rigid Glass Fiber Insulation (where exposed to view in public areas).
      1) Pipe Size Range: All sizes.
      2) Thickness: 1 1/2 inch.

6. Chilled Drinking Water:
   a. Elastomeric Cellular Foam Insulation:
      1) Pipe Size Range: All sizes.
      2) Thickness: 3/4 inch.

7. Condensate Drain Lines (50 degrees F. and above):
   a. Polyisocyanurate Foam Insulation:
      1) Pipe Size Range: All sizes.
      a) Thickness: 1/2 inch.
   b. Rigid Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
      a) Thickness: 1/2 inch in conditioned mechanical rooms; 1 1/2 inch above ceilings or in unconditioned spaces.
   c. Elastomeric Cellular Foam Insulation:
      1) Pipe Size Range: All sizes.
      a) Thickness 3/4.
      b) Note 1 inch is 25/100 flame/smoke.

B. Exhaust Ducts:
1. Rectangular Sheet Metal Ductwork: 1 inch Thick Flexible Glass Fiber Duct Liner Insulation. In addition, wrap last 15 feet at connection to
exhaust fans with 1 1/2 inch thick Flexible Glass Fiber Ductwork Insulation, Exterior.

2. Round Sheet Metal Ductwork: 1 1/2 inch Thick Flexible Glass Fiber Ductwork Insulation, Exterior.

C. RTVAV Return Air Ducts: 2 inch thick, 3 pound per cubic foot density, Minimum Installed R=8.7 Rigid Fiberglass Liner Board.


E. RTU-2 Return Duct: Flexible Glass Fiber Ductwork Insulation, Exterior, Minimum Installed R=6.0. In addition, provide 1 inch Thick Flexible Glass Fiber Acoustical Duct Liner.

F. Supply Ducts: Flexible Glass Fiber Ductwork Insulation, Exterior, Minimum Installed R=6.0. First fifteen (15) feet of duct from rooftop unit connection shall also be lined with 1 inch Thick Flexible Glass Fiber Duct Liner (except RTU-1, delete liner).

G. Backside of Diffusers: Flexible Glass Fiber Ductwork Insulation, Minimum installed R=8.0.

H. VAV Terminal Boxes: Externally insulate electric heating sections with Flexible Glass Fiber Ductwork Insulation, Exterior, Minimum Installed R=6.0.

I. Roof Penetration Hood: Two layers of 1" inch thick elastomeric insulation, Armacell ArmaTuff or equal or painted exterior with two (2) coats of UV resistant paint.

J. Grease Exhaust Ducts and Top Side of Kitchen Exhaust Hoods: 1 1/2 inch Thick Fireblanket Insulation.

END OF SECTION
SECTION 15140
DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including the "Mechanical and Electrical Specifications (Common Conditions)", is a part of these Plumbing Specifications.

B. Sections of the Specifications covering General Conditions and supplements are a part of the contract. Contractor shall observe all requirements thereof, insofar as they pertain to his work.

1.2 SUMMARY

Provide materials and installation for complete first class plumbing system, within and to five feet beyond building perimeter unless noted otherwise on Contract Drawings; Domestic Water Piping, Domestic Water Valves, Testing and other normal parts that make the systems operable, code compliant and acceptable to the authorities having jurisdiction.

1.3 REFERENCES

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1.4 SUBMITTALS

A. Section 15010 - Mechanical General Conditions: Submittals.

B. Product Data: Submit data on pipe materials; pipe fittings, valves, and accessories. Submit manufacturers catalog information. Indicate valve data and ratings.

C. Manufacturer's Installation Instructions: Submit installation instructions for valves and accessories.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and equipment.

B. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

1.6 QUALITY CONTROL

A. Manufacturer’s name and pressure rating shall be permanently marked on valve body.

B. The Contractor shall notify the manufacturer’s representative prior to installing any copper press fittings. The Contractor shall obtain the representative’s guidance in any unfamiliar installation procedures. The manufacturer’s representative of copper press fittings shall conduct periodic inspections of the installation and shall report in writing to the Contractor and Owner of any observed deviations from manufacturer’s recommended installation practices.

C. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this Section.

D. Installer Qualifications:
   1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.
   2. All installers of copper press fittings shall be trained by the fitting Manufacturer’s appointed representative. Written notification of training shall be submitted to Owner prior to any installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be new, undamaged, and free of rust.

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.

E. Protect all materials that are to be installed within this project from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for exterior locations.
1.8 ENVIRONMENTAL REQUIREMENTS
Do not install underground piping when bedding is wet or frozen.

1.9 FIELD MEASUREMENTS
Verify field measurements prior to fabrication.

1.10 EXTRA MATERIALS
Furnish two (2) packing kits for each size valve and two (2) loose keys for outside hose bibbs.

1.11 TEMPORARY CONNECTIONS
Plumbing contractor shall provide temporary water connection required for construction purposes.

1.12 RELATED WORK SPECIFIED ELSEWHERE
A. The following related work is specified elsewhere.
   1. Condensate drain piping from equipment furnished by the HVAC Contractor to drains provided by the Plumbing Contractor.
   2. Installation of flashing and waterproofing.
   3. Concrete bases for water heaters where indicated on the Drawings. Bases shall extend 3” beyond all sides of the heater.
   4. Furnish and install all electrical wiring required for electric water coolers, electric water heaters, and hot water circulating pumps.
   5. Splashblocks.

1.13 DISPOSAL OF EXCAVATED MATERIAL
Excavated materials, so far as needed and of a suitable and acceptable character, shall be piled adjacent to the excavations to be used as backfill as required. All excavated material that is unsuitable for backfilling purposes, or which is in excess of the amount required or needed to satisfactorily complete the backfill, shall be piled at a location on the site designated by the Owner.

1.14 SERVICE CONNECTIONS
A. Domestic water piping located outside lines of building shall be terminated outside lines of building at locations indicated on the Drawings.

B. Contractor shall arrange with the proper authority for the installation of a new water meter if required. Refer to the Civil Drawings for the water meter if required. Plumbing Contractor shall pay all costs involved for this service.
1.15 TEST OF WATER PIPING

Water piping shall be tested under 125 PSI hydrostatic pressure for a period of no less than twelve (12) hours. Any leaks made evident shall be repaired and the test repeated to completion.

PART 2 PRODUCTS

2.1 WATER PIPING, BURIED OUTSIDE OF BUILDING

A. PVC Pipe:
   1. 2” through 4” pipe size – PVC Pipe: ASTM D2241 SDR 26 for not less than 150 PSI pressure rating.
      c. Fittings: Solvent weld.

2.2 WATER PIPING BELOW BUILDING STRUCTURE AND THRU SLAB

A. Piping Sizes 1½” through 3”:
   1. Copper Tubing: ASTM B88 Type L, K, hard drawn.
   2. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze or Pro Press fittings by Viega. Copper press fittings shall have a specific design feature to guarantee that unpressed fittings will not hold at any pressure between 15 and 85 PSIG. Press fittings from various manufacturers shall not be mixed.
   3. Joints: ASTM B32, solder, Grade 95TA.
   4. Solder shall be lead free and antimony free and shall conform to the Safe Water Drinking Act Amendments, enforceable since June 1988. Solder shall be Silverbrite 100 as manufactured by Englehard Corporation or approved equal.

2.3 WATER PIPING UNDER FLOOR SLAB AND TRAP-PRIMER PIPING

A. Copper Tubing: ASTM B42, Type K soft. 1 1/2” pipe size and smaller.
   2. Joints: No joints allowed below slab.
   3. Trap-primers: All piping below slab or installed in concrete or masonry floors and walls shall be encased in a polyethylene sleeve, “Polysleeve” or equal.
   4. Pressure Water Piping: All piping below slab on grade shall be encased in a Schedule 40 PVC sleeve.

2.4 WATER PIPING, ABOVE GRADE

A. Piping Sizes ½” through 3”:
   1. Copper Tubing: ASTM B88 Type L, K, hard drawn.
   2. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze or Pro Press fittings by Viega. Copper press fittings shall have a specific design feature to guarantee that un-
pressed fittings will not hold at any pressure between 15 and 85 PSIG. Press fittings from various manufacturers shall not be mixed.

3. Joints: ASTM B32, solder, Grade 95TA.

4. Solder shall be lead free and antimony free and shall conform to the Safe Water Drinking Act Amendments, enforceable since June 1988. Solder shall be Silverbrite 100 as manufactured by Englehard Corporation or approved equal.

2.5 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 4 inches and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.
   2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, and water impervious isolation barrier.

2.6 PIPE HANGERS AND SUPPORTS

A. Plumbing Piping: Conform to ASME B31.9 ASTM F708.

B. Refer to Section 15060 – Hangers, Supports, and Foundations.

2.7 GATE VALVES

A. Manufacturers:
   1. Stockham.
   2. Jenkins.
   4. Crane.
   5. Substitutions: Section 15010 – Mechanical General Conditions.

B. 3 inches and Larger: Class 125, iron body, bronze trim, rising stem, outside screw and yoke, hand wheel, double wedge disc, flanged ends.

2.8 BALL VALVES

A. Manufacturers:
   1. Stockham.
   2. Jenkins.
   4. Crane.
   5. Substitutions: Section 15010 – Mechanical General Conditions.

B. Construction, 2 inches and Smaller: Class 150, bronze, one piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder or threaded ends with union.
2.9 SWING CHECK VALVES

A. Manufacturers:
   1. Mission Model Duo-Chek.
   2. Stockham.
   3. Crane.
   4. Jenkins.
   5. Substitutions: Section 15010 – Mechanical General Conditions.

B. Up To and Including 2 inches: Class 125, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends.

C. 2 inches and Larger: Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged ends.

2.10 SPRING LOADED CHECK VALVES

A. Manufacturers:
   1. Mission.
   2. Stockham.
   3. Crane.
   4. Jenkins.
   5. Substitutions: Section 15010 – Mechanical General Conditions.

B. Class 125, iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

2.11 RELIEF VALVES

A. Manufacturers:
   1. Watts.
   2. Substitutions: Section 15010 – Mechanical General Conditions.

B. Temperature and Pressure Relief: AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME SEC IV certified and labeled.

2.12 FIRE STOP SYSTEMS

A. Manufacturers:
   1. 3M Model 2000.
   2. Spec Seal Model 100.
   3. Hilti.
   4. Substitutions: Section 15010 – Mechanical General Conditions.

B. General Purpose Fire Stopping Sealant: Water based, non-slumping, premixed sealant with intumescent properties, rated for three (3) hours in accordance with ASTM E814 and UL 1479.
2.13 HOSE BIBBS
A. Refer to Plumbing Fixture Schedule on Drawings for specification of hose bibbs.
B. Select inlet configuration to match thickness of wall for wall hydrants.

2.14 RECESSED WATER VALVE BOX
A. Manufacturers:
   1. Sioux Chief.
   2. Substitutions: Section 15010 – Mechanical General Conditions.
B. Refer to Plumbing Fixture Schedule on Drawings for Specifications of recessed valve boxes.

2.15 BACKFLOW PREVENTERS
A. Manufacturers:
   1. Watts.
   2. Substitutions: Section 15010 – Mechanical General Conditions.

2.16 WATER HAMMER ARRESTORS
A. Manufacturers:
   1. Zurn.
   2. Wade.
   4. Substitutions: Section 15010 – Mechanical General Conditions.
B. ANSI A1126.1; stainless steel copper construction, bellows type sized in accordance with PDI WH-201.
C. Pre-charged suitable for operation in temperature range -100 to 300 degrees F (-73 to 149 degrees C) 34 to 250 degrees F (1 to 120 degrees C) and maximum 250-psi (1700 kPa) 150 psi (1000 kPa) working pressure.

2.17 THERMOSTATIC MIXING VALVES
Refer to Plumbing Fixture Schedule on Drawings for specification of thermostatic mixing valves.

2.18 THERMOMETERS
Furnish and install thermometers where indicated. Thermometers shall be Trerice or equal Catalog No. A405 industrial thermometer, 9" aluminum case, adjustable angle, brass separable socket, 30 to 240 degrees F. range.
2.19 SLEEVES

A. For pipes 4” and under and passing through partitions, walls, and floors – galvanized steel pipe.

B. For pipes 4” and over and passing through partitions, walls, and floors – minimum 16 gauge galvanized sheet metal.

C. Where approved by Engineer prior to installation, at floor penetration in slab on grade construction, flexible foam pipe wrap such as “Flex-Wrap” by Cal-Western may be substituted for sleeve.

D. Cover trap-primer piping embedded in concrete floors and walls with “Poly-sleeve” or equal polyethylene sleeve material.

2.20 TRAP-PRIMERS

Refer to Plumbing Fixture Schedule and Details on Drawings for specification of trap-primers.

2.21 UNDER COUNTER PROTECTIVE PIPE COVERS

A. Manufacturers:
   1. Trubro.
   2. Plumberex.
   3. Substitutions: Section 15010 – Mechanical General Conditions.

B. Insulate per ADA 4.19.4 and ICC/A117.1, all drainage piping including all hot and cold water valve and supplies under lavatories and / or sinks. PVC insulation material shall also meet IBC testing standards ASTM E84-07.

2.22 SUPPLY STOPs

Chrome-plated, brass body angle stop with removable seat, loose T-handle key, chrome-plated supply tube and chrome-plated escutcheon.

PART 3 EXECUTION

3.1 EXAMINATION

Verify excavations are to required grade, dry, and not over-excavate.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.
D. Excavate and backfill in accordance with Architectural Specifications, and Section 15010 – Mechanical General Conditions.

3.3 INSTALLATION

A. Install Work in accordance with manufacturer’s instructions.

B. Install shut-off valves located above ceilings at a height and location that is readily and safely accessible to maintenance personnel from an eight-foot stepladder.

C. Install non-conducting dielectric connections wherever jointing dissimilar metals.

D. No bushings will be allowed in any piping. Copper or brass adapters shall be used for joining copper pipe to screwed valves or fittings.

E. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

F. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.

G. Group piping whenever practical at common elevations.

H. Furnish and install compression type stops on supply piping to all fixtures including kitchen equipment and fixtures.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 15125 – Piping Expansion Compensation.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 15060 – Hangers and Supports.

K. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Architectural Division prior to installation.

L. Isolate copper piping from contact with metal wall studs or other metal structures.

M. Establish elevations of buried piping outside the building to obtain not less than three feet of cover.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

O. Provide hose bib, or wall hydrant where shown on plans, at each entrance for system drain down. Valve and hose bib shall be arranged so as not to interfere with normal pedestrian traffic.
P. Hot water relief lines shall not discharge onto walkways, or entrances.

Q. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.

R. Install valves with stems upright or horizontal, not inverted.

S. Install water piping in accordance with ASME B31.9.

T. Install concrete thrust blocks at all changes in direction of underground piping.

U. Sleeve pipes passing through partitions, walls and floors. At penetrations of exterior walls, fill annular space in sleeve with non-combustible material. Caulk and seal weather-tight and vermin-tight.

V. Provide fire-stopping sealant at all piping penetrations of fire rated barriers.

W. Install potable water protection devices on plumbing lines where contamination of domestic water may occur; janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.

X. Pipe relief from valves, back-flow preventers and drains to nearest floor drain. Pipe relief from temperature and pressure relief valves to outdoors where possible.

Y. Install water hammer arrestors on cold water supply piping where shown on Drawings or as required for all fast closing valves as per code.

Z. Install air chambers on hot and cold water supply piping to each fixture or group of fixtures. Fabricate same size as supply pipe or 3/4 inch minimum and minimum 18 inches long. Air chambers need not be installed where water hammer arrestors are in place.

AA. Cover water and waste piping underneath ADA compliant fixtures with protective pipe covering kits.

BB. Trench safety system shall comply with the appropriate requirements established in the Occupational Safety and Health Administration (OSHA) Safety Health Requirements, Part 1926, Subpart P, Excavation, Trenching, and Shoring.

CC. Identify piping utilizing copper press fittings with markers stating, “Press-Fit” adjacent to each content identification marker.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Install unions downstream of valves and at equipment or apparatus connections.
B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Install globe or ball valves for throttling, bypass, or manual flow control services.

E. Provide spring loaded check valves on discharge of water pumps.

F. Provide flow controls in water circulating systems where indicated.

3.5 ERECTION TOLERANCES

Slope water piping minimum 0.25 percent and arrange to drain at low points.

3.6 DISINFECTING OF DOMESTIC WATER

A. Prior to starting work, verify system is complete, flushed, and clean.

B. Verify 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 and tablet or gas form, throughout system to obtain residual from 50 to 80 mg/L.

D. Bleed water from outlets to obtain distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. When final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual concentration is equal to 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.

3.7 SCHEDULES

METAL PIPE HANGER SPACING

A. Pipe size: 1/2 to 1-1/4 inches:
   1. Maximum hanger spacing: 6.5 ft.

B. Pipe size: 1-1/2 to 2 inches:
   1. Maximum hanger spacing: 10 ft.

C. Pipe size: 2-1/2 to 3 inches:
   1. Maximum hanger spacing: 10 ft.
   2. Hanger rod diameter: 1/2 inch.

END OF SECTION
PART 1  GENERAL

1.1  RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the “Mechanical and Electrical Specifications (Common Conditions)”, is a part of these Plumbing Specifications.

B. Sections of the Specifications covering General Conditions and supplements are a part of the Contract. Contractor shall observe all requirements thereof, insofar as they pertain to his work.

1.2  SUMMARY

Provide materials and installation for complete first class plumbing system, within and to five (5) feet beyond building perimeter unless noted otherwise on Contract Drawings. Sanitary, Waste, Grease Waste and Vent piping, pipe fittings, connections, equipment for sanitary and grease waste piping systems, floor drains, cleanouts, interceptors, testing, and other normal parts that make the system operable, code compliant, and acceptable to the authorities having jurisdiction. This section also includes floor drains, cleanouts and grease interceptors.

1.3  REFERENCES

A. The latest published editions of a reference shall be applicable to this project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this project.

C. All materials, installation, and workmanship shall comply with the applicable requirements and standards addressed within the following references: 2009 Edition of the International Plumbing Code.

1.4  SUBMITTALS

A. Section 15010 - Mechanical General Conditions: Submittals.

B. Product Data: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information. Indicate component sizes, rough-in requirements, service sizes, and finishes.

C. Include manufacturer’s Installation Instructions.

D. Provide full written description of manufacturer’s warranty.
1.5 CLOSEOUT SUBMITTALS

A. Section 15010 – Mechanical General Conditions – General Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of clean-outs.

1.6 DELIVERY, STORAGE, AND HANDLING

Section 15010 – Mechanical General Conditions: Product Handling, Receiving, Inspection, and Storage.

1.7 ENVIRONMENTAL REQUIREMENTS

Do not install underground piping when bedding is wet or frozen.

1.8 FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

1.9 WARRANTY

Refer to Section 15010 – Mechanical General Conditions.

1.10 TEST OF SOIL, GREASE, INDIRECT WASTE AND VENT PIPING SYSTEMS

Soil, waste, indirect waste, grease waste and vent piping shall be given a water test. Piping shall have openings plugged necessary and be filled with water to the level of top of vent pipe and allowed to stand for not less than twelve (12) hours for inspection, after which, if the lines prove tight, the water shall be drawn off, and the fixtures connected.

1.11 SERVICE CONNECTIONS

A. Sanitary sewer piping shall be terminated outside lines of buildings at locations indicated on the Drawings.

B. Refer to Civil Drawings for new sanitary sewer service. Prior to commencement of work, verify that invert elevations of new and existing sewers are sufficient to maintain slopes and depth below frost line.

PART 2 PRODUCTS

2.1 SANITARY SEWER AND GREASE WASTE PIPING BURIED WITHIN FIVE (5) FEET OF BUILDING

A. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC – DWV.

2.2 SANITARY SEWER, GREASE WASTE, INDIRECT WASTE AND VENT PIPING, ABOVE GRADE

   1. Fittings: PVC – DWV.

B. Cast Iron Pipe: ASTM A74, service weight, hub and spigot.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
   3. Piping below slab on grade shall be hub and spigot up through the first joint above slab.

2.3 SANITARY SEWER, INDIRECT WASTE, AND VENT PIPING WITHIN RETURN AIR PLENUM

A. CPVC Pipe, Type IV: ASTM Cell Classification 23447, Schedule 40. For use in ceiling return air plenums.
   3. All pipe, fittings, and components shall be CAN/ULC S102.2 listed for flame spread and smoke development rating of 25/50 or below with rating designated on the pipe marking.

B. Cast Iron Pipe: ASTM A74, service weight, hub and spigot.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
   3. Piping below slab on grade shall be hub and spigot up through the first joint above slab.

C. Cast Iron Pipe: CISPI 301, hub-less, service weight.
   1. Fittings: Cast iron.
   3. No Hub Coupling: 4 inch and smaller pipe size shall have 3 inch wide corrugated 304 stainless steel shield with four stainless steel clamps mounted in a series, secured in place by means of a fixed and floating eyelet to allow the clamp travel during tightening. 6 inch and larger pipe size shall have 4 inch wide corrugated 304 stainless steel shield with six stainless steel clamps mounted in a series, secured in place by means of a fixed and floating eyelet to allow the clamp travel during tightening. Coupling to be as manufactured by Anaheim Foundry Company, HUSKY series 4000.
   4. Piping shall be hub-less beginning at the hub and spigot joint located immediately above floor slab.
D. Copper Tube: ASTM B306, DWV, Type K, L.
   1. Fittings: ASME B123, cast bronze, or ASME B129, wrought copper.
   2. Joints: ASTM B32, solder, Grade 50B.

2.4 GREASE TRAPS (INTERCEPTORS)

A. A grease interceptor system shall be provided and installed as indicated on plans. Refer to Plumbing Fixture Schedule for specification of grease interceptors. The system shall be installed in strict accordance with the manufacturer's recommendations local code requirements.

B. Grease interceptor system shall be provided with a set of installation, operation, and maintenance manuals that contain clear and concise descriptions.

C. Grease interceptor system design shall conform to criteria set forth by the International Association of Plumbing and Mechanical Officials (IAPMO), to ASME grease interceptor standard #A112.14.3 and CSA B481.1, and all other governing state and local code requirements.

D. Contractor shall submitted required copies of manufacturer's equipment specification for engineer's review. Shop drawings shall include the following:
   1. Detailed manufacturer's data including installation plan/elevation drawings.
   2. Manhole frame/cover specifications.
   3. Pipe and Tank Specifications.
   5. Anchor Kit.

2.5 PIPE HANGERS AND SUPPORTS


B. Refer to Section 15060 – Hangers, Supports, and Foundations.

2.6 FIRE STOP SYSTEMS

A. Manufacturers:
   1. 3M Model 2000.
   2. Spec Seal Model 100.
   3. Hilti.

B. General Purpose Fire Stopping Sealant: Water based, non-slumping, premixed sealant with intumescent properties, rated for three (3) hours in accordance with ASTM E814 and UL 1479.

C. General Purpose Vibration Resistant Fire Stopping Sealant: Silicone based, non-slumping, premixed sealant with intumescent properties, vibration and moisture resistant, rated for 3 hours in accordance with ASTM E814 and UL 1479.
D. DWV Plastic Pipe Systems Fire Stopping Sealant: Silicone based, premixed sealant with intumescent properties, vibration and moisture resistant, rated for three (3) hours in accordance with ASTM E814 and UL 1479 with metal collars.

2.7 FLOOR DRAINS

A. Refer to Approved Manufacturers Schedule on Drawings with regards to acceptable floor drain manufacturers.

B. Refer to Plumbing Fixture Schedule on Drawings for Specifications on floor drains.

C. Substitutions: Section 15010 – Mechanical General Conditions.

D. Floor Drain: ANSI A1121.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar and adjustable nickel-bronze strainer.

E. Accessories: Provide strainers as indicated on Drawings. On second floor and above, provide lead flashing and flashing flange, or other flashing material as required by Contract Documents.

2.8 CLEANOUTS

A. Refer to Approved Manufacturers Schedule on Drawings with regards to acceptable cleanout manufacturers.

B. Refer to Plumbing Fixture Schedule on Drawings for Specifications on cleanouts.

C. Substitutions: Section 15010 – Mechanical General Conditions.

D. Exterior Surfaced and Unsurfaced Areas: Round cast nickel bronze access frame and non-skid cover.

E. Interior Finished Floor Areas: Lacquered cast iron body with polished nickel bronze scoriated top, adjustable housing, anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and round depressed cover with gasket to accept floor finish in finished floor areas.

F. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.

G. Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.
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. Excavate and backfill in accordance with Architectural Specifications, and Section 15010 – Mechanical General Conditions.

3.2 INSTALLATION

A. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearances at cleanout for snaking drainage system.
B. Encase exterior cleanouts in concrete flush with grade.
C. Install floor cleanouts at elevation to accommodate finished floor.
D. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
E. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
F. Install piping to maintain headroom. Do not spread piping, conserving space.
G. Group piping whenever practical at common elevations.
H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 15080 – Mechanical Insulation.
J. Provide access where valves and fittings are not exposed. Provide access panels in accessible walls and ceilings.
K. Establish elevations of buried piping outside building to provide not less than three (3) feet of cover.
L. Maintain code-mandated clearances between sanitary sewer, domestic water, and electrical conduit.
M. At vents-through-wall, provide proper sealing and install in accordance with Section 15060 – Hangers, Supports and Foundations.
N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

O. Excavate and backfill in accordance with Section 15010 – Mechanical General Conditions.

P. Install bell and spigot pipe with bell end upstream.

Q. Sanitary tees shall be installed in a vertical position only. Where installation is in the horizontal position, provide a sanitary wye and ¼ bend or combination fitting. Tapped tees may be installed in the vertical position at drinking fountains, lavatories, or cleanouts only. Tapped crosses are prohibited except where specifically indicated on Drawings.

R. Sleeve pipes passing through partitions, walls, and floors. Where approved by Engineer prior to construction, at floor penetration in slab on grade, flexible foam wrap such as “Flex-Wrap” by Cal-Western may be substituted for sleeve.

S. Piping below slab on grade shall be hub and spigot up through the first joint above slab.

T. Coat PVC piping exposed to sunlight with ultraviolet resistant paint.

3.3 ERECTION TOLERANCES

Establish invert elevations, slopes for drainage to 1/4 inch per foot minimum. Maintain gradients. Where existing conditions require, 1/8 inch per foot slope may be used on 4 inch and larger pipe where approved by local code authority prior to installation.

3.4 SCHEDULES

**METAL-PIPE HANGER SPACING:**

A. Pipe size: 1/2 to 1-1/4 inches:
   1. Maximum hanger spacing: 5 ft.

B. Pipe size: 1-1/2 to 2 inches:
   1. Maximum hanger spacing: 10 ft.

C. Pipe size: 2-1/2 to 3 inches:
   1. Maximum hanger spacing: 10 ft.
   2. Hanger rod diameter: 1/2 inch.

D. Pipe size: 4 to 6 inches:
   1. Maximum hanger spacing: 10 ft.
PLASTIC-PIPE HANGER SPACING:

E. All Sizes:
1. Maximum hanger spacing: 6 ft.

END OF SECTION
SECTION 15160
STORM DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY
Section includes pipe, pipe fittings and connections for storm water piping systems. This Section also includes roof drains and cleanouts.

1.2 SUBMITTALS
A. Section 15010 – Mechanical General Conditions: Submittals.
B. Product Data: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information. Submit component sizes, rough-in requirements, service sizes, and finishes.

1.3 CLOSEOUT SUBMITTALS
A. Project Record Documents: Record actual locations of equipment and cleanouts.
B. Operation and Maintenance Data: Submit spare parts lists, exploded assembly views for pumps and equipment.

1.4 ENVIRONMENTAL REQUIREMENTS
Do not install underground piping when bedding is wet or frozen.

1.5 WARRANTY
Refer to Section 15010 – Mechanical General Conditions.

PART 2 PRODUCTS

2.1 STORM WATER PIPING ABOVE GRADE
   1. Fittings: PVC – DWV.
B. PVC Pipe: ASTM D1785 Schedule 40, or ASTM D2241 SDR-26 for not less than 150 psi (1 034 kPa) pressure rating.
   1. Fittings: ASTM D2466, PVC.
2.2 STORM WATER PIPING ABOVE GRADE WITHIN RETURN AIR PLENUMS

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: Neoprene gaskets and wide body stainless steel clamp-and-shield assemblies as manufactured by Tyler, Husky or Clamp-All.
   3. Coupling: Heavy duty, all stainless steel coupling with four clamps on pipe sizes through 4 inch and six clamps on pipe sizes over 4 inch. Couplings shall be designed to be installed with a pre-set torque wrench at 80 psi. Couplings shall be as manufactured by Husky, Series 4000.
   4. Piping shall be hubless beginning at the hub and spigot joint located immediately above floor slab.

B. CPVC Pipe, Type IV: ASTM Cell Classification 23447, Schedule 40. For use in ceiling return air plenums.
   3. All pipe, fittings, and components shall be CAN/ULC S102,2 listed for flame spread and smoke development rating of 25/50 or below with rating designated on the pipe marking.

2.3 PIPE HANGERS AND SUPPORTS


B. Refer to Section 15060 – Hangers, Supports, and Foundations.

2.4 FIRE STOP SYSTEMS

A. Manufacturers:
   1. 3m Model 2000.
   2. Spec Seal Model 100.
   3. Hilti.
   4. Substitutions: Section 15010 – Mechanical General Conditions.

B. General Purpose Fire Stopping Sealant: Water based, non-slumping, premixed sealant with intumescent properties, rated for 3 hours in accordance with ASTM E814 and UL 1479.

C. General Purpose Vibration Resistant Fire Stopping Sealant: Silicone based, non-slumping, premixed sealant with intumescent properties, vibration and moisture resistant, rated for 3 hours in accordance with ASTM E814 and UL 1479.

2.5 PRIMARY ROOF DRAINS

A. Manufacturers:
   1. Watts.
   2. Substitutions: Section 15010 – Mechanical General Conditions.
B. Accessories: Coordinate with roofing type; refer to Architectural Sections.
   1. Membrane flange and membrane clamp with integral gravel stop.
   2. Adjustable under deck clamp as required.
   3. Roof sump receiver.
   5. Leveling frame.
   6. Adjustable extension sleeve for roof insulation.

2.6 CLEANOUTS

A. Exterior Surfaced Areas: Round cast nickel bronze access frame and non-skid cover.

B. Exterior Unsurfaced Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket.

C. Interior Finished Floor Areas: Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and round depressed cover with gasket to accept floor finish in finished floor areas.

D. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.

E. Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

PART 3 EXECUTION

3.1 CEILING PLENUM

In occupied spaces where there is no suspended ceiling or ceiling space is used as a return air plenum, storm drain piping shall be constructed of CPVC or cast iron material with flame spread/smoke development rating of 25/50.

3.2 EXAMINATION

Verify excavations are to required grade, dry, and not over-excavated.

3.3 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

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

D. Excavate and backfill in accordance with Architectural Specifications and Section 15010 – Mechanical General Conditions.
3.4 INSTALLATION

A. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearance at cleanout for snaking drainage system.

B. Encase exterior cleanouts in concrete flush with grade.

C. Install floor cleanouts at elevation to accommodate finished floor.

D. Install non-conducting dielectric connections wherever jointing dissimilar metals.

E. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

F. Install piping to maintain headroom. Group piping to conserve space.

G. Group piping whenever practical at common elevations.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 15125 – Piping Expansion Compensation.

I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to cleanouts. Refer to Section 15080 – Mechanical Insulation.

J. Insulate bottom side of roof drain body with 1 1/2” thick insulation. Refer to Section 15080 – Mechanical Insulation.

K. Insulate vertical drop from roof drain and all horizontal piping. Refer to Section 15080 – Mechanical Insulation.

L. Establish elevations of buried piping outside building to provide not less than 2 ft of cover.

M. Install piping penetrating roofed areas to maintain integrity of roof assembly.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

O. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.

P. Install bell and spigot pipe with bell end upstream.

Q. Sleeve pipes passing through partitions, walls and floors. Where approved by Engineer prior to construction, at floor penetration of slab on grade flexible foam wrap such as “Flex-Wrap” by Cal-Western may be substituted for sleeve.
R. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9 ASTM F708.
   2. Refer to Section 15060 – Hangers, Supports, and Foundations.

3.5 ERECTION TOLERANCES

Establish invert elevations, slopes for drainage to 1/4 inch per foot minimum, or as shown on Drawings. Maintain gradients.

3.6 SCHEDULES

METAL-PIPE HANGER SPACING:

A. Pipe Size: 2 1/2 to 3 inch:
   1. Maximum hanger spacing: 10 ft.
   2. Hanger rod diameter: 1/2 inch.

B. Pipe Size: 4 to 6 inch:
   1. Maximum hanger spacing: 10 ft.

C. Pipe Size: 8 to 12 inch:
   1. Maximum hanger spacing: 14 ft.

PLASTIC-PIPE HANGER SPACING:

D. All Sizes:
   1. Maximum hanger spacing: 6 ft.

END OF SECTION
SECTION 15300
FIRE SPRINKLER SYSTEMS

PART 1  GENERAL

1.1 SECTION INCLUDES
   A. Wet-Pipe Sprinkler System.
   C. Fire Department Connections.

1.2 REFERENCES
   NFPA 13 - Installation of Sprinkler Systems.

1.3 SYSTEM DESCRIPTION
   A. System to provide coverage for entire building utilizing a single zone fire sprinkler system.
   B. Provide system to NFPA 13, occupancy requirements.
   C. Determine volume and pressure of incoming water supply from water flow test data.
   D. Interface system with building fire and smoke alarm system.
   E. Provide fire department connections as indicated.

1.4 SUBMITTALS
   A. Submit under provisions of Section 15010 – Mechanical General Conditions: Submittals.
   B. Preliminary Shop Drawings: Prior to detailed submission, submit preliminary layout of finished ceiling areas indicating only head locations coordinated with ceiling installation.
   C. Shop Drawings: Indicate hydraulic calculations, detailed pipe layout, hangers, and supports, components, and accessories. Indicate system controls.
   D. Product Data: Provide data on sprinkler heads, valves, and specialties, including manufacturers’ catalogue information. Submit performance ratings rough-in details, weights, support requirements, and piping connections.
E. Submit shop drawings, product data, and hydraulic calculations to Owner's insurance underwriter for approval. Submit proof of approval to Architect/Engineer.

F. Samples: Submit one (1) of each style of sprinkler head specified.

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

1.5 PROJECT RECORD DOCUMENTS

Record actual locations of sprinkler heads and deviations of piping from Drawings. Indicate drain and test locations.

1.6 OPERATION AND MAINTENANCE DATA

Maintenance Data: Include components of system, servicing requirements, Record Drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 13, 13 R.

B. Equipment and Components: Bear UL, FM label or marking.

1.8 QUALIFICATIONS

A. Installer: Company specializing in performing work of this Section with minimum three (3) years experience.

B. Design fire sprinkler system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas.

1.9 REGULATORY REQUIREMENTS

Hydraulic Calculations, Product Data, and Shop Drawings: Bear stamp of approval of Owner's fire insurance underwriter.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and protect products to site under provisions of Section 15010 – Mechanical General Conditions.

B. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.
1.11 EXTRA MATERIALS

A. Provide extra sprinkler heads under provisions of NFPA 13.
B. Provide suitable wrenches for each head type.
C. Provide metal storage cabinet in location designated.

PART 2 PRODUCTS

2.1 SPRINKLER HEADS

A. Manufacturers:
   1. Tyco.
   2. Victaulic.
   3. Reliable.
   4. Viking.

B. Suspended Ceiling:
   1. Type: Standard concealed pendant type with matching push on escutcheon plate.
   2. Head Finish: Chrome plated.
   4. Fusible Link: Fusible solder link type or Glass bulb type temperature rated for specific area hazard.

C. Exposed Area Type:
   1. Type: Standard upright type with guard.
   2. Head Finish: Brass.
   3. Fusible Link: Fusible solder link type or Glass bulb type temperature rated for specific area hazard.

D. Sidewall Type:
   1. Type: Extended Coverage horizontal sidewall type with matching push on escutcheon plate and guard.
   2. Head Finish: Brass.
   3. Escutcheon Plate Finish: Chrome plated.
   4. Fusible Link: Fusible solder link type or Glass bulb type temperature rated for specific area hazard.

E. Guards: Finish to match sprinkler head.

2.2 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate electrically or hydraulically operated alarms, with pressure retard chamber and variable pressure trim.

B. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy red enameled gong and motor housing, nylon bearings, and inlet strainer.
C. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch.

D. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts rated 10 amps at 115 volt AC.

E. Fire Department Connection:
   1. Type: Flush mounted wall type with chrome plated finish.
   2. Outlets: Two way with thread size to suit fire department hardware; threaded dust cap and chain of matching material and finish.
   4. Label: "Sprinkler - Fire Department Connection".

F. Fire Department Outlet Valve: Angle type; brass finish; 2 ½ inch (65mm) size, thread to match fire department hardware, 300 psig working pressure, with threaded cap and chain of same material and finish.

G. At locations where supply pipes, risers, system risers or teed mains pass through any unheated spaces and possibility of space temperature of less than 40 degree F exist, it shall be contractor’s responsibility to protect against freezing by insulating coverings, frost proof casings, electric tracer or other reliable means capable of maintaining a minimum of 40 degree F.

PART 3 EXECUTION

3.1 PREPARATION

Coordinate work of this Section with other affected work.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturer’s instructions.

B. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.

C. Locate outside alarm gong on building wall.

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

E. Place piping in concealed spaces above finished ceilings.

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

G. Apply masking tape or paper cover to ensure concealed sprinkler head cover plates do not receive field paint finish.
H. Where static pressure exceeds 100 psi at any hose station, provide pressure reducing valve to prevent pressure on hose exceeding 90 psi.

I. Flush entire piping system of foreign matter.

J. Hydrostatically test entire system.

K. Require test be witnessed by Fire Marshall.

END OF SECTION
SECTION 15310
FIRE PROTECTION PIPING

PART 1 GENERAL

1.1 RELATED WORK

Section 15300: Fire Sprinkler System.

1.2 QUALITY ASSURANCE

A. Underwriters Laboratories (UL) listed and Factory Mutual (F.M.) approved material.

B. UL 2443 Standard for Flexible Sprinkler Hose with Fittings for Fire Protection Service.

C. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.

D. Manufacturer Qualifications: Manufacturer capable of providing field service representation during installation.

E. Fabricator Qualifications: Fabrication performed in quality controlled manufacturing environment by experienced fabricators with references indicating multiple satisfactory experiences fabricating flexible stainless steel hose assemblies as required for this project.

1.3 SUBMITTALS AND SHOP DRAWINGS

A. Include the following manufacturer's product data with shop drawings:
   1. Valves.
   2. Pipe and fittings.
   3. Detailing installation procedures, including layout, dimensions and support placement.
   4. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
   5. Manufacturer’s Instructions: Manufacturer’s installation instructions.

1.4 APPLICABLE CODES (LATEST ADOPTED ADDITION) AND REFERENCES


C. FM Class Number 1637 Approval Standard for Flexible Sprinkler Hose with Threaded End Fittings.

D. NFPA 13 Standard for the Installation of Sprinkler Systems.

E. UL 2443 Standard for Flexible Sprinkler Hose with Fittings for Fire Protection Service.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and protect products to site under provisions of Section 15010 – Mechanical General Conditions.

B. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

C. Store flexible stainless steel hose with fittings for fire protection service inside and away from the elements to prevent accidental damage prior to installation.

1.6 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, not a limitation of, other rights Owner may have under Contract Documents.

PART 2 PRODUCTS

2.1 VALVES

A. Acceptable Manufacturers:
   1. Nibco.
   2. Crane.
   5. Mueller.
   7. Hersey.
   8. Feebco.

B. Nibco model numbers are used to establish required level of product quality.

C. Outside System Valves:
   1. Gate Valves:
a. Nibco No. F-607-OTS, UL Listed and F.M. approved, bolted bonnet, outside screw and yoke, solid wedge, pregrooved for tamper switch mounting, 175 lb wwp.
b. Nibco No. F-609, UL Listed and F.M. approved, bolted bonnet, non-rising stem, solid wedge, 175 lb wwp.
c. For direct buried valves, provide cast iron roadway box extended to grade.

D. Interior System Valves:
1. Check Valves:
2. Gate Valves: Nibco F-607-OTS, UL-F.M. approved flanged pattern outside screw and yoke, 175 psi WP.
3. Butterfly Valves: Nibco WD3510-8 or LD3510-8, wafer or lug style, UL Listed, F.M. approved, 250 lb wwp, lug style 200 psi wwp dead end rated, internal tamper switch.
4. Ball Valves: Nibco No. KT-505-8 or G-505-8, threaded or grooved, UL listed, F.M. approved, bronze body, three piece, internal tamper switches, 300 psi wwp.

2.2 PIPE AND FITTINGS

A. Underground Pipe and Fittings, buried 5 feet beyond building perimeter to above floor slab:
1. Ductile Iron Pipe:
   a. Acceptable Manufacturers:
      1) U.S. Pipe.
      2) Clow.
      3) American.
   b. Minimum Class 52, cement-lined ductile iron in accordance with AWWA C151/ANSI A21.51. Provide bituminous seal coat on inside of pipe and bituminous coat on outside.
2. PVC Pipe, buried up to 5 feet of building perimeter:
   a. Acceptable Manufacturers:
      1) Clow "Super Main 900".
      2) Manville "Blue Brute".
      3) CertainTeed "VinylIron".
      4) H&W Industries, Inc.
   b. Minimum Class 100 in accordance with AWWA C900 and SDR14, shall be UL. And NSF61 listed and Factory Mutual approved.
3. Joints and Fittings:
   b. Push-on Joints (AWWA C111/ANSI 21.11). Where joint restraint is needed, provide restrained push-on joint pipe and
fittings in accordance with ANSI/AWWA C151/A21.51 and C111/A21.11.
c. Mechanical joint, bell with flange, cast iron gland, rubber gasket and bolts and nuts, UL listed and F.M. approved (ANSI/AWWA C110/A21.10).

4. Material used shall be approved by local code authorities.

B. Interior Pipe and Fittings:
3. Fittings:
   a. Mechanical Couplings: Roll or cut groove rigid type by Victaulic, Central Grooved, or Grinnell.
   b. Class 125 or Class 250 cast iron sprinkler fittings - screwed, flanged, or grooved-end.
   c. All fittings shall be by the same manufacturer.
4. Drain Piping:
   a. Schedule 40, A106 or A120, galvanized pipe.
   b. Fittings: Class 250 malleable iron, screwed with galvanized coating.

C. Flexible Stainless Steel Hose With Fittings For Fire Protection Service:
1. Manufacturer: FlexHead Industries, Inc.
   a. Substitutions: No substitutions permitted.
2. Provide flexible stainless steel hose assemblies that comply with NFPA 13.
3. FlexHead Flexible Hose Assemblies and End Fittings:
   a. Composition: 100% Type 304 Stainless Steel
   b. Straight Hose Assembly Lengths: 2 foot lengths, 3 foot lengths, 4 foot lengths, 5 foot lengths, and 6 foot lengths.
      1) 1/2 inch, 3/4 inch outlet.
      2) 175 psi, 300 psi maximum rated pressure.
      3) Fully welded non-mechanical fittings, braided, leak-tested with minimum 1 inch true-bore internal corrugated hose diameter.
   c. Elbow Hose Assembly Lengths: 2 foot lengths, 3 foot lengths, 4 foot lengths, 5 foot lengths, and 6 foot lengths.
      1) 1/2 inch, 3/4 inch outlet.
      2) 175 psi, 300 psi maximum rated pressure.
      3) Fully welded non-mechanical fittings, braided, leak-tested with minimum 1 inch true-bore internal corrugated hose diameter.
4. Ceiling Bracket:
   a. Composition: Galvanized steel.
   b. Type: Multi-port style having self-securing integrated snap-on clip ends that attach directly to the ceiling with tamper-resistant screws.
   c. Flexible Hose Attachment: Removable hub type with set screw.
d. Acceptable Material: FlexHead Industries, Inc., Model 
#MP24BKT2 ceiling bracket.

2.3 HANGERS AND SUPPORTS

A. Acceptable Manufacturers:
   1. Grinnell.
   2. Bline.
   3. Viking.
   4. Reliable Empire.
   5. Fee.
   6. Mason.

B. Grinnell model numbers are used to establish level of product quality.

C. Provide UL Listed and F.M. approved hangers.

D. Hangers:
   1. Grinnell #260 MSS, Type 1 for pipe 2" through 12".
   2. Grinnell Figure #104, Type 6, adjustable split ring for pipe less than 2".
   3. Grinnell #69 for pipe 1/2" through 2".

E. Clamps:
   1. Riser Clamps: Grinnell #261, MSS Type 8, at floor slab penetrations to support risers.
   2. C-Clamps: Grinnell #92 with retainer clip, MSS Type 23.
   3. Malleable Beam Clamps: Grinnell Figure #218, MSS Type 30.

F. Inserts:
   1. Concrete Insert: Grinnell Figure #281, MSS Type 18, universal concrete insert, adequately sized and correctly positioned to support full load.
   2. Lightweight Concrete: Grinnell #285.
   3. Continuous Concrete Insert: Grinnell Powerstrut #PS-349, pregalvanized.
   4. Power Insert: HILTI HDI expansion anchor. Use in conjunction with all thread rods.
   5. Power inserts shall not be used in post tension construction unless approved by Structural Engineer.

2.4 PIPE INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Fire protection piping located outside lines of building shall be terminated five (5) feet outside lines of building at the location indicated on the Drawings.
C. Install underground pipe work to provide a minimum cover of 2.5 feet; 3 foot cover under drives and roads, or below frost line as required per N.F.P.A. 24 figure A-8-1.1., whichever is greater.

D. Exterior underground piping shall be buried with a permanent, bright colored, continuous printed plastic tape. Tape shall be intended for direct burial and buried directly above fire protection main. Tape shall be 6" wide, 4 mils thick. Tape shall be printed with proper identification of service located below.

E. Install piping as high as possible to conserve building space and not interfere with use of space and other Work. Coordinate with other trades to avoid conflicts and provide all required offsets, piping, auxiliary drains, etc. to properly install system.

F. Use hanger types as specified in Part 2 above. This shall overrule hanger types outlined in NFPA 13.

G. Hanger spacing shall be in accordance with NFPA 13.

H. Provide hangers on all arm outs of 12" or more.

I. Group piping whenever practical at common elevations.

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

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

L. Seal penetrations of fire rated walls and floors in accordance with UL Fire Resistance Index for Through-Penetration Firestop Systems. Coordinate requirements with Division 7.

M. Provide trapeze type hangers where necessary to support pipe when structural steel is not directly above for support.

PART 3 EXECUTION

3.1 Comply with manufacturer’s written data, including product technical bulletins, product catalog installation instructions, product carton installation instructions and FlexHead Industries’ SPEC-DATA sheet.

3.2 Verify substrate conditions are acceptable for product installation in accordance with manufacturer’s instructions.

3.3 Examine area to receive insulation for compliance with installation clearances.

3.4 Comply with manufacturer’s installation instructions.

3.5 Ensure facility fire protection system is inactive during maintenance or inspection.
3.6 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, and protection of its product[s], and submit written reports in acceptable format to verify compliance of Work with Contract.

3.7 After installation and prior to final acceptance, inspect flexible sprinkler assembly for any damage and confirm proper installation. Replace damaged components prior to activating fire protection system.

3.8 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION
SECTION 15410
PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Water Closets.
B. Urinals.
C. Sinks.
D. Lavatories.
E. Mop Basins.
F. Drinking Fountains.
G. Hydrants/Hose Bibbs.
H. Flush Valves.
I. Carriers.
J. Specialty Fixtures.

1.2 RELATED SECTIONS

A. Section 15000 - Mechanical and Electrical Specifications (Common Conditions).
B. Section 15010 - Mechanical General Conditions.
C. Section 15058 - Access Doors.
D. Section 15060 - Hangers, Supports, and Foundations.
E. Section 15140 - Domestic Water Piping.
G. Refer to Architectural Sections of the Specifications for Owner furnished items, toilet and bath accessories, and lab equipment.
1.3 REFERENCES
A. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
B. ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
C. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
D. ASME A112.19.2 - Vitreous China Plumbing Fixtures.
E. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
F. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW
A. Section 15010 - Mechanical General Conditions: Submittals.
B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS FOR INFORMATION
A. Section 15010 - Mechanical General Conditions: Submittals.
B. Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT
A. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE
Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.8 REGULATORY REQUIREMENTS
Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION
A. Transport, handle, store, and protect products.
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.

1.10 WARRANTY

Provide five (5) year manufacturer warranty for electric water coolers.

PART 2 PRODUCTS

2.1 GENERAL

A. See Plumbing Fixture Schedule on Plans for descriptions.

B. Refer to Approved Manufacturers Schedule on Drawings with regards to acceptable plumbing fixture manufacturers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

C. Verify that electric power is available and of the correct characteristics.

D. Confirm that millwork is constructed with adequate provision for the 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.

B. Coordinate work of this section with other affected work.

3.3 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall carriers and bolts.
E. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.

F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.4 INTERFACE WITH OTHER PRODUCTS

Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

Clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

Do not permit use of fixtures.

END OF SECTION
SECTION 15420
EMERGENCY EYE WASH EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

A. Provide all materials and labor for emergency eye wash equipment, and associated piping, supports, valves, and accessories to provide complete, operable, and code compliant installation that is acceptable to the authorities having jurisdiction.

B. Emergency eye wash equipment addressed by this specification shall be installed within conditioned or ventilated spaces having ambient temperatures between 60 and 100 degrees Fahrenheit.

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
   3. Texas Department of Licensing and Regulation, Texas Accessibility Standards of the Architectural Barriers Act, Article 9102, Texas Civil Statutes.
   6. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
1.4 QUALITY ASSURANCE

A. All materials shall be new, undamaged, and free of rust. Protect installed products and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, rust, etc. Remove dirt and debris as Work progresses.

B. Manufacturer Qualifications: Company shall have minimum three (3) years documented experience specializing in manufacturing the products specified in this section.

C. Installer Qualifications: Company shall have minimum three (3) years documented experience specializing in performing the Work of this Section. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

1.5 SUBMITTALS

A. Product Data: Provide Code and Standards compliance, component dimensions, service sizes and finishes.

B. Record Documents:
   1. Record actual locations of supply isolation valves, emergency eye wash equipment installed.
   2. Provide full written description of manufacturer’s warranty.
   3. Manufacturer’s Installation Instructions: Indicate assembly and support requirements, adjustment and testing procedures.

C. Operation and Maintenance Data:
   1. Record actual locations of supply isolation valves, emergency eye wash equipment installed.
   2. Provide full written description of manufacturer’s warranty.

1.6 DELIVERY, STORAGE AND HANDLING

A. Accept equipment and materials on Site in shipping containers and maintain in place until installation.

B. Protect installed equipment from damage and/or entry of foreign materials by temporary covers during the construction phase of this Project.

C. Do not allow use of installed equipment for any reason, other than testing, during the construction phase of this Project.

D. Protect all materials before and after installation from exposure to rain, freezing temperatures and direct sunlight.
PART 2 PRODUCTS

2.1 GENERAL

A. See Plumbing Fixture Schedule on Plans for descriptions.


C. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

D. Provide emergency equipment as indicated and scheduled on the Contract Drawings and as specified herein.

E. Pressure ratings of equipment and related accessories shall be suitable for the anticipated system pressures in which they are installed.

F. Equipment and components of same type shall be product of one (1) manufacturer.

G. All emergency equipment shall meet American with Disabilities Act (ADA) accessibility requirements for activation of controls and height of eye/face outlets.

H. Emergency equipment activation devices shall be designed so that the flushing water remains on without requiring the use of the operator's hands. The valve shall be designed to remain activated until intentionally shut off.

I. Eye/Face Wash unit shall provide flushing fluid at 3 gallons per minute at a minimum 30 pounds per square inch water pressure.

2.2 EMERGENCY EYE/FACE WASH

A. Barrier-free design with coated galvanized steel piping; stainless steel eye wash bowl; chrome-plated brass spray head assembly with twin, soft flow, eye/face wash heads and protective spray head covers; Chrome-plated 1/2 inch IPS stay-open ball-type eye wash valve hand operated by a large, highly visible safety push handle; universal identification sign; inspection tag, and 1/2 inch water supply connection.

B. Emergency eye/face wash units shall be Bradley or approved equal by an acceptable manufacturer listed herein.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine roughing-in for plumbing piping systems to verify actual locations of piping connections prior to installation of emergency equipment. Proceed with installation only after unsatisfactory conditions have been corrected.
B. Coordinate location of emergency equipment with General Contractor to allow identification of required clear floor space area for emergency shower access.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install emergency eye/face wash equipment in accordance with manufacturer’s published instructions.

D. Locate emergency equipment on a level surface area for user.

E. Safety equipment shall not be located within eighteen (18) inches of electrical apparatus, telephones, thermostats, or power outlets.

F. Emergency eyewash nozzles shall be positioned 33 inches- 45 inches from floor and at least 6” from wall or nearest obstruction.

G. Provide and accessible ball type shutoff valve in individual water supply line serving safety equipment. Valves shall be labeled for identification and locked in the open position.

H. Provide and install stainless steel escutcheons on piping wall and ceiling penetrations in exposed, finished locations.

I. Coordinate with General Contractor for location and installation of emergency equipment identification signage and inspection tags.

3.3 TESTING

A. Adjust or replace fixture flow regulators for proper flow.

B. After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve required flows.

C. Report test results in writing.

END OF SECTION
SECTION 15480
ELECTRIC DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

This section covers providing all labor and materials for the complete first class tank type domestic water heaters indicated on Contract Drawings complete with all controls, piping, valves, wiring, supports, accessories, testing, and other normal parts required for complete, code compliant, operable installation that is acceptable to the authorities having jurisdiction.

1.2 REFERENCES

C. Underwriters Laboratories (UL) Listings.

1.3 SUBMITTALS

A. Submit under provisions of Section 15010 – Mechanical General Conditions.
B. Shop Drawings: Include dimensions of tanks, tank lining methods, tappings, and drains.
C. Product Data:
   1. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Provide electrical characteristics and connection requirements.
D. Manufacturer's Installation Instructions.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 15010 – Mechanical General Conditions.
B. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of Texas standards.
B. Heaters shall be designed to limit the maximum temperature to avoid scalding.
C. Manufacturer Qualifications: Company shall have minimum three (3) years documented experience specializing in manufacturing the products specified in this section.

D. Provide equipment with manufacturer’s name, model number, and rating/capacity permanently identified.

E. Water heater shall meet or exceed the minimum energy factor requirements of ASHRAE Standard 90.1b-2001.

F. Installer Qualifications: Company shall have minimum three (3) years documented experience specializing in performing the Work of this section. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas Board of Plumbing Examiners and under the direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

G. Products and installation of specified products shall be in conformance with recommendations and requirements of the following:
   1. National Sanitation Foundation (NSF).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site.

B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.7 WARRANTY

A. Provide three (3) year warranty under provisions of Section 15010 – Mechanical General Conditions.

B. Warranty: Include coverage of domestic water heaters.

PART 2 PRODUCTS

2.1 GENERAL

See Plumbing Fixture Schedule on plans for description.

2.2 DOMESTIC WATER HEATERS

A. Acceptable Manufacturers:
2. State.
3. Rheem.

B. Furnish and install domestic hot water heaters with dimensions, capacities and electrical characteristics as scheduled on the Contract Drawings and as outlined herein. This Specification describes minimum quality and performance requirements. Variations of system components by the individual referenced manufacturers are acceptable for installation in this project provided they meet or exceed all of the requirements indicated herein, are compatible with the electrical service provided and fit properly in the allocated space.

C. Heating elements element shall be controlled by an individually mounted thermostat and high temperature cutoff switch. Heaters having double-elements shall be provided with simultaneous wiring to permit both elements to operate at the same time.

D. Water heater shall have a properly sized, factory provided temperature and pressure relief valve.

E. The tank drain valve shall be located in the front for ease of servicing.

2.3 VACUUM RELIEF VALVES

A. Construction shall be bronze body with silicone disc having a dry guide which is located out of the water. Unit shall open at less than 1/2” vacuum and be suitable for use within a system having a maximum water pressure of 200 psi and a maximum temperature of 250°F. Vacuum relief valves shall be in compliance with the appropriate requirements of ANSI Z21.22.

B. Vacuum relief valves shall be manufactured by Watts Regulator, Wilkins or Conbraco.

PART 3 EXECUTION

3.1 PREPARATION

Coordinate with millwork and architectural drawings before installation of water heater. Provide proper wall supports.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state, and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.
C. Install water heaters, piping, wiring, and accessories in accordance with the manufacturer's installation instructions.

D. Furnish all supports required by the equipment included in this Contract in accordance with the manufacturer's published instructions.

E. Relief valve shall not discharge into safety pan.

F. Safety pan and relief valve drain lines shall be copper and installed so that all water will drain completely out of the piping. Where it is impractical or physically impossible to extend a drain line to the building exterior, drain lines shall discharge separately into a floor drain, housekeeping mop sink or other location approved by the Engineer.

G. Each water heater shall be provided with clear access and unobstructed passageway that is adequate to allow removal and replacement.

H. Install heater in a vertical position with required manufacturer clearances servicing. Coordinate location of unit to avoid conflicts with other system or building components.

I. Furnish and install all necessary valves, strainers, unions, etc. to facilitate proper functioning and servicing of equipment.

J. Provide dielectric isolation device where copper lines connect to ferrous lines or equipment.

K. Install an accessible line size shutoff valve in cold water inlet within two feet of heater.

L. Provide heat trap inlet piping for storage type heaters to prevention migration of heated water into cold water system.

M. Provide heat trap in outlet piping for storage type heaters serving non-circulated distribution systems.

N. Provide a vacuum relief valve in cold water supply to heaters having bottom feed inlet. Install valve in accordance with manufacturer's recommendations.

O. Provide a temperature gauge in the outlet piping adjacent to storage type heaters. Locate gauge in an easily readable position.

P. Flush water supply line to remove all air, scale, and dirt prior to connecting heater.

Q. Take precautions to prevent heat generated by soldering procedures from being transmitted to heater components.

R. Coordinate with Electrical Contractor for power and wiring required. Verify that electrical power is connected to a properly grounded dedicated branch
circuit of proper voltage rating and equipped with ground fault interrupter. Each heater shall be provided with an independent circuit. Insure that the correct wire and circuit breaker sizes are provided.

S. When all plumbing installation is completed, check for leaks and take corrective action before proceeding. Flow hot water until temperature has stabilized. Verify and insure that the water meets scheduled temperature at all outlets. Clean water heater prior to final inspection of installation.

3.3 TRAINING

Contractor shall instruct and acquaint the Owner with the proper functioning, operation and maintenance of the water heater and all associated installed components.

END OF SECTION
PART 1 GENERAL

1.1 RELATED SPECIFICATIONS
   A. Comply with Division 1 - General Requirements and referenced documents.
   B. Comply with all other Division 15 Sections as applicable. Refer to other Divisions for coordination of work with other trades as required.

1.2 SYSTEM DESCRIPTION
   The scope shall include all packaged variable volume roof top air conditioning units, supports and all appurtenances.

1.3 QUALITY ASSURANCE
   A. All equipment and materials shall be new and of the best quality.
   B. All equipment and materials shall be installed in a workmanlike manner by experienced mechanics and as recommended by the manufacturer.

1.4 SUBMITTALS
   A. Product Data: Submit manufacturer's descriptive literature and installation instructions. Submit fan curves for all fans.
   B. Shop Drawings: Submit in accordance with Section 15010 - Mechanical General Conditions.

1.5 PRODUCT HANDLING
   A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.
   B. Storage and protection of materials shall be in accordance with Section 15010 - Mechanical General Conditions.

PART 2 PRODUCTS

2.1 EQUIPMENT
   A. Contractor shall provide fully assembled variable air volume rooftop air conditioning units as detailed and scheduled on the Plans.
      1. Acceptable Manufacturers:
         a. Trane.
         b. McQuay.
c. Carrier.

B. General:
1. Units shall be specifically designed for outdoor rooftop installation on a roof curb and be completely factory assembled and tested, piped, internally wired, fully charged with R-410A compressor oil, factory run tested and shipped in one piece. Units shall be available for direct expansion cooling only.

2. Filters, outside air system, barometric relief air system, disconnect switches and all operating and safety controls shall be furnished factory installed. All units shall be UL listed to US and Canadian Safety Standards. Cooling capacity shall be rated in accordance with ARI Standard 360. All units shall have decals and tags to aid in service and indicate caution areas. Electrical diagrams shall be printed on long life water resistant material and shall ship attached to control panel doors.

C. Casing: Exterior panels shall be zinc coated galvanized steel, phosphatized and painted with a slate grey air-dry finish durable enough to withstand a minimum of 500 hours consecutive salt spray application in accordance with standard ASTM B117. Screws shall be coated with zinc-plus-zinc chromate. Heavy gauge steel hinged access panels with tiebacks to secure door in open position shall provide access to filters and heating sections. Refrigeration components, supply air fan, and compressor shall be accessible through removable panels as standard. Unit control panel and filter section shall be accessible through hinged access panels as standard. Double Wall Construction hinged access doors shall provide access to filters, return, relief air and supply fan section. All access doors and panels shall have neoprene gaskets. Interior surfaces or exterior casing members shall have ½ inch fiberglass insulation. Unit base shall be watertight with heavy gauge formed load bearing members, formed recess and curb overhang. Unit lifting lugs shall accept chains or cables for rigging. Lifting lugs shall also serve as unit tie down points.

D. Provide all necessary components and controls to allow for economizer mode operation based on outdoor ambient enthalpy conditions.

2.2 REFRIGERATION SYSTEM

A. Compressors: Provide scroll compressors which shall include a direct-drive, 3600 rpm, suction gas cooled hermetic motor. Provide motor protection by utilizing either a patented motor cap and integral line break motor protector or an external 24 VAC module which provides protection against incorrect phase sequence, excess motor temperatures, over current protection, and phase loss. The compressor shall include a centrifugal oil pump, scroll tips seals, internal heat shield, oil level sight glass, and oil charge valve. Provide a low leakage internal discharge check valve to help prevent refrigerant migration in addition to a dip tube to allow for oil draining. Each compressor shall have a crankcase heater installed, properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

B. Evaporator Coil: Internally enhanced copper tubing of 3/8 or ½-inch O.D. shall be mechanically bonded to heavy duty aluminum fins of configured design. All
coils shall be equipped with thermal expansion valves and factory pressure and leak tested.

C. Drain Pan: Drain Pan shall be of stainless steel construction or other non-corrosive material with threaded drain line connections. Slope drain pan so that standing water will not accumulate in pan.

D. Condenser Coil: Configured aluminum fin secondary surface shall be mechanically bonded to primary surface of 5/16-inch O.D. internally enhanced copper tubing for extra corrosion resistance or micro-channel coil. Subcooling circuit(s) shall be provided as standard. All coils shall be factory pressure tested and vacuum dehydrated.

E. Condenser Fans and Motors: All condenser fans shall be vertical discharge, direct drive fans, statically balanced, with steel blades and zinc plated steel hubs. Condenser fan motors shall be three-phase motors with permanently lubricated ball bearings, built-in current and thermal overload protection, and weathertight slingers over motor bearings.

F. Air Handling System:
   1. Supply Fan: All supply fans shall be direct drive plenum type and shall be dynamically balanced and tested in factory. Supply fan shall be test run in unit as part of unit test and unit shall reach rated rpm before the fan shaft passes through first critical speed. Fan shaft shall be mounted on two grease lubricated ball bearings designed for 200,000 hours average life. Extended grease lines shall allow greasing of bearings from unit filter section. Fan motor and fan assembly shall be mounted on common base to allow consistent belt tension with no relative motion between fan and motor shafts. Entire assembly shall be completely isolated from unit and fan board by double deflection rubber-in shear isolators, or by optional two-inch deflection spring isolation. All supply fan motors meet the U.S. Energy Policy Act of 1992 (EPACT).
   2. Controls: Unit shall be completely factory wired with necessary control and contactor pressure lugs or terminal block for power wiring. Unit mounted microprocessor controls shall provide anti-short cycle timing for compressors to provide a high level of machine protection. Unit controls shall be complete with fuses, starters, contactors, relays, and switches.

G. Unit Controller:
   1. DDC microprocessor controls shall be provided to control all unit functions. The controls shall be factory-installed and mounted in the main control panel. All factory-installed controls shall be fully commissioned (run tested) at the factory. The unit shall have a Microprocessor Interface Panel with a key keypad, and a clear English display as standard to provide the operator with full adjustment and display of control data functions. The unit controls shall be used as a stand-alone controller, or as part of a building management system involving multiple units.
   2. The unit shall be equipped with a complete microprocessor control system. This system shall consist of temperature and pressure (thermistor and transducer) sensors, printed circuit boards (modules),
and a unit mounted Human Interface Panel. Modules (boards) shall be individually replaceable for ease of service. All microprocessors, boards, and sensors shall be factory mounted, wired, and tested. The microprocessor boards shall be stand-alone DDC controls not dependent on communications with an on-site PC or a Building Management Network. The microprocessors shall be equipped with on-board diagnostics, indicating that all hardware, software, and interconnecting wiring are in proper operating condition. The modules (boards) shall be protected to prevent RFI and voltage transients from affecting the board's circuits. All field wiring shall be terminated at separate, clearly marked terminal strip. Direct field wiring to the I/O boards is not acceptable. The microprocessor's memory shall be non-volatile EEPROM type requiring no battery or capacitive backup, while maintaining all data.

3. The unit shall have a network interface card to connect to a third party building management system. Coordinate with the Controls Manufacturer.

4. Zone sensors shall be available in several combinations with selectable features depending on sensor.

5. The Microprocessor Interface Panel's keypad display character format shall be a minimum of 40 characters x 2 lines. The display shall be Liquid Crystal Display (LCD) with blue characters on a gray/green background which provides high visibility and ease of interface. The display format shall be in clear English. Two or three digit coded displays are not acceptable.

6. The keypad shall be equipped with touch-sensitive membrane key switches. The switches shall be divided into four separate sections and be password protected from change by unauthorized personnel. The six main menus shall be STATUS, SETPOINTS, DIAGNOSTICS, SETUP, CONFIGURATION, and SERVICE MODE.

7. Unit controller shall be compatible with building management system (LONTalk or BACNet). Coordinate with the Controls Contractor to provide all necessary integration requirements prior to ordering equipment. Provide the Controls Control with necessary points list during start-up/controls commissioning

H. Filters: Filter components shall mount integral within unit and be accessible by hinged access panels.

1. Two inch throwaway filter rack: Shall provide a complete set of two-inch thick filter racks, without the filter media to accommodate applications which require field supplied filters.

2. Throwaway Filters: Filters are 2” thick, MERV 8, UL Class 2, glass fiber type. Filters rated at 80% average synthetic dust weight arrestance when tested in accordance with ASHRAE 52-76 and 52.1 test methods. Filters mounted in galvanized steel rack.

3. Filter Sensor: A differential pressure sensor and transmitter mounted on filter section shall through the building management system signal a dirty filter alarm of an adjustable differential pressure set point (0.10” to 1.0” W.G.).

I. Exhaust Air – Barometric relief: Gravity dampers shall open to relieve positive pressure in the return air section of the rooftop. Barometric relief dampers shall
relieve building overpressurization, when that overpressurization is great enough to overcome the return duct pressure drops.

J. Outside Air – 0 to 100 percent modulating: Operated through the primary temperature controls to automatically modulate return and OA dampers shall maintain proper temperature in the conditioned space. Provide with an automatic lockout when the outdoor high ambient temperature is too high for proper cooling. Minimum position control shall be standard and adjustable through the building management system. A spring return motor shall ensure closure of OA dampers during unit shut down or power interruption. Mechanical cooling shall be available to aid the modulating mode at any ambient temperature. Low leak economizer dampers shall be standard with a leakage rate of 2.5 percent of nominal airflow (400 CFM/ton) at 1 inch w.g. static pressure. Outdoor air moisture eliminators shall be included as standard to prevent moisture from being drawn into the unit even when operating with 100% outside air.

K. Airflow Measuring Station - The Airflow Measuring Station shall consist of Airflow Measuring Device with multi port sensing tubes across at least 75% of the area at the face of the intake hood or duct to ensure accurate and stable readings. The flow measurements shall be accurate to +/- 5% from 100% down to 15% of nominal flow. It shall also be capable of temperature and altitude compensation correcting for changes in air density. The measurement probes or flow rings shall provide a differential pressure signal to the VCM and the DDC controller shall convert the 0-10 VDC signal into airflow (CFM). The CFM measurement may be passed from the DDC controller as a 0-10 VDC signal or communicated through either a LONTalk® or BACNet® network. The electronic damper actuator shall operate in response to the DDC controller's signal to properly position the outside air damper based on ventilation requirements.

L. Accessories – Roof Mounting Curb: Unit shall be furnished with a minimum 14-inch high factory fabricated, acoustical style solid bottom roof curb fully gasketed between the curb top and unit bottom with the curb. Coordinate curb height with Architectural to provide a minimum of 8” from finished roof to top of curb. Roof mounting curb shall be heavy gauge zinc coated steel with nominal two-inch by four-inch nailer setup. Supply/return air opening gasketing shall be provided. Curb shall ship knocked down for easy assembly. Channel shall be provided to allow for adjustment of return air opening location. Supply air and return air sections of the curb shall be divided and sealed air tight to allow the return section to be used as a return air plenum. Curb shall be manufactured to National Roofing Contractors Association guidelines.

M. Electrical:
1. Units shall have single point connection. Provide factory installed 115 volt, 13 amp ground fault service receptacle.
2. Electronic Zone Sensors: Zone Sensors shall provide two (2) temperature setpoint levers, Auto, Off, or Cool system switch, Fan Auto or Fan On switch. Optional status indication LED lights, System On, Cool, and Service shall be available.
   a. Programmable Night Setback Sensors shall be electronic programmable sensors with auto or manual changeover with 7
day programming. Keyboard shall provide selection of Cool, Fan Auto or On. All programmable sensors shall have System On, Cool, Service LED/ indicators as standard. Night setback sensors shall have (1) Occupied, (1) Unoccupied and (2) Override programs per day. Sensors shall be available for Zone Temperature Control and Supply Air Temperature Control.

b. Discharge Temperature Control sensor shall be provided with supply air single temperature setpoint and AUTO/OFF system switch. Status indication LED lights shall include: System On, Cool and Service.

c. Remote Sensor shall be available to be used for remote zone temperature sensing capabilities when zone sensors are used as Remote panels.

d. Integrated system sensors shall be available with sensor only, sensor with timed override, and sensor with local temperature setpoint adjustment with timed override.

e. Remote Minimum Position Potentiometer shall be available to remotely adjust the minimum position setting of the unit’s economizer.

f. Humidity sensor shall be available to monitor the humidity levels in the space for Humidification purposes.

N. Corrosion Protection: Provide a factory applied Phenolic coating on the condenser coils.

O. Additional Requirements: Refer to Drawings for additional requirements.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units in strict accordance with Manufacturer’s instructions.

B. Provide condensate drain line with trap per Manufacturer’s instructions and route to nearest plumbing drain or as shown on plans.

END OF SECTION
SECTION 15789
PACKAGED ROOFTOP AIR CONDITIONING UNITS WITH ELECTRIC HEAT

PART 1 GENERAL

1.1 RELATED SPECIFICATIONS
   A. Comply with Division 1 - General Requirements and referenced documents.
   B. Comply with all other Division 15 Sections as applicable. Refer to other Divisions for coordination of work with other trades as required.

1.2 SYSTEM DESCRIPTION
The scope shall include all packaged roof top air conditioning units, supports and all appurtenances.

1.3 QUALITY ASSURANCE
   A. All equipment and materials shall be new and of the best quality.
   B. All equipment and materials shall be installed in a workmanlike manner by experienced mechanics and as recommended by the manufacturer.

1.4 SUBMITTALS
   A. Product Data: Submit manufacturer's descriptive literature and installation instructions. Submit fan curves for all fans.
   B. Shop Drawings: Submit in accordance with Section 15010 - Mechanical General Conditions.

1.5 PRODUCT HANDLING
   A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.
   B. Storage and protection of materials shall be in accordance with Section 15010- Mechanical General Conditions.

PART 2 PRODUCTS

2.1 EQUIPMENT
   A. Contractor shall furnish and install fully assembled rooftop air conditioning units as detailed and scheduled on the Plans. Unit shall consist of insulated weather-tight casing with pitch roof, compressor, evaporator and condenser air system, outside air intake, condensate drain pan, evaporator fan, motor and drive, heating section, filter, and roof mounting curb.
1. Acceptable Manufacturers:
   a. Trane.
   b. Lennox.
   c. McQuay.
   d. Carrier.

2.2 PACKAGED ROOFTOP UNIT

A. General: The units shall be dedicated down flow airflow. The operating range shall be between 115°F and 0°F in cooling as standard from the factory for all units. Cooling performance shall be rated in accordance with ARI testing procedures. All units shall be factory assembled, internally wired, fully charged with R-410A, and 100 percent run tested to check cooling operation, fan and blower rotation and control sequence, before leaving the factory. Wiring internal to the unit shall be colored and numbered for simplified identification. Units shall be UL listed and labeled, classified in accordance to UL 1995/C 22.2, 236-05 3rd Edition.

B. Casing: Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested 672 hours in a salt spray test in compliance with ASTM B117. Cabinet construction shall allow for all maintenance on one side of the unit. In order to ensure a water and air tight seal, service panels shall have lifting handles and no more than three screws to remove. All exposed vertical panels and top covers in the indoor air section shall be insulated with a 1/2 inch, 1 pound density foil-faced, fire-resistant, permanent, odorless, glass fiber material. The base of the downflow unit shall be insulated with 1/2 inch, 1 pound density foil-faced, closed-cell material. The downflow unit's base pan shall have no penetrations within the perimeter of the curb other than the raised 11/8 inch high supply/return openings to provide an added water integrity precaution, if the condensate drain backs up. The base of the unit shall have provisions for forklift and crane lifting.

C. Filters: Two inch pleated, MERV 8, standard filters shall be factory supplied on all units.

D. Compressors: All units shall have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of nameplate voltage. Internal overloads shall be provided with the scroll compressors. All models shall have crankcase heaters, phase monitors, and low and high pressure control as standard.

E. Crankcase Heaters: Provide band heaters to operate during off-cycles or low ambient conditions.

F. Refrigerant Circuits: Each refrigerant circuit shall have independent thermostatic expansion devices, service pressure ports, and refrigerant line filter driers factory installed as standard. An area shall be provided for replacement suction line driers.
G. Evaporator and Condenser Coils: Provide internally finned, 5/16” copper tubes mechanically bonded to configured aluminum plate fins. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil and condenser coil shall be leak tested to 200 psig and pressure tested to 450 psig. Sloped condensate drain pans are standard.

H. Electric Heating Section: Units shall be constructed with completely assembled, wired, electric heating systems integral within unit. Provide helix-wound, nickel-chrome, electric-resistance elements and factory wired with time delay for element staging, and overcurrent and overheat protective devices. Heater shall have pilot duty or automatic reset line voltage limit controls.

I. RTU-1 Hot gas reheat coil: Provide hot gas reheat coil of similar construction to the evaporator coil. Provide controls necessary for modulating or staging capacity control to measure and control discharge air temperature during reheat.

J. Outdoor Fans: The outdoor fan shall be direct-drive, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motor(s) shall be permanently lubricated and shall have built-in thermal overload protection.

K. Indoor Fan: Units above shall have belt driven, FC centrifugal fans with adjustable motor sheaves. Units with standard motors shall have an adjustable idler-arm assembly for quick-adjustment of fan belts and motor sheaves. All motors shall be thermally protected. All indoor fan motors meet the U.S. Energy Policy Act of 1992 (EPACT).

L. Controls: Unit shall be completely factory wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Unit shall provide an external location for mounting a fused disconnect device. Controls shall be provided for all 24 volt control functions. The resident control algorithms shall make all heating, cooling, and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm shall maintain accurate temperature control and minimize drift from set point. A centralized control shall provide anti-short cycle timing and time delay between compressors as protection. Provide a network integration module compatible with the building DDC management system. Coordinate with the Controls Manufacturer. Provide the Controls Control with necessary points list during start-up/controls commissioning.

M. Defrost Controls: Provide adaptive demand defrost to permit defrost wherever coil icing conditions begin to significantly reduce unit capacity.

N. Discharge Line Thermostat: Provide a bi-metal element discharge line thermostat installed on the discharge line of each system. Wire discharge line thermostat in series with high pressure control. Provide a manual reset to resume operation after unit trips.

O. Phase Monitor: Provide a 3-phase line monitor module to protect against phase loss, phase reversal, phase unbalance, and reverse rotation of compressors. The monitor should operate with an operating input voltage range of 190-600
VAC, and LED indicators for ON and FAULT. The module shall automatically reset from a fault condition.

P. Factory Installed Options:
1. Coated Coils: Factory shall provide phenolic coating on assembled condenser coils
3. Powered Convenience Outlet: Provide a GFCI, 120v/15amp, two (2) plug, powered convenience outlet. When the convenience outlet is powered, a service receptacle disconnect will be available. The convenience outlet is powered from the line side of the disconnect or circuit breaker, and therefore will not be affected by the position of the disconnect or circuit breaker. This option can only be ordered when the Through the Base Electrical with either the Disconnect Switch or Circuit Breaker option is ordered.
4. Through the Base Electrical with Disconnect Switch: Provide a three-pole, molded case, disconnect switch with provisions for through the base electrical Connections. The disconnect switch shall be installed in the unit in a water tight enclosure with access through a swinging door. Factory wiring will be provided from the switch to the unit high voltage terminal block. The switch will be UL/CSA agency recognized.
5. Through the Base Utilities Access: Provide an electrical service entrance to allow electrical access for both control and main power connections inside the curb and through the base of the unit. Option must allow for field installation of liquid-tight conduit and an external field installed disconnect switch.
6. Smoke Detector: By Others. Coordinate interlock requirements for unit shut down with General Contractor/Electrical Contractor.

Q. Factory or Field Installed Options:
1. Clogged Filter/Fan Failure Sensor: Provide a dedicated differential pressure sensor to achieve active fan failure indication and/or clogged filter indication. A filter sensor and transmitter mounted on filter section shall signal a dirty filter alarm of an adjustable differential pressure set point (0.10” to 1.0” W.G.). These indications will be registered with an integrated signal through the building management control system.
2. Differential Pressure Switches: Provide pressure switches to allow for individual fan failure and dirty filter indication. The fan failure switch shall disable all unit functions and "flash" the Service LED on the zone sensor. The dirty filter switch shall light the Service LED on the zone sensor and will allow continued unit operation.
3. Communications Interface: Provide a 3rd party communications interface to allow the unit to communicate through a device or directly with the building Automation System Controls.
4. Hail Guards: Provide hail protection quality coil guards for condenser coil protection.

R. Field Installed Options:
1. RTU-2 CO2 Sensing: Provide a CO2 sensor to monitor space occupancy levels within the building by measuring the parts per million of
CO2. Refer to drawings for location. Refer to Specification section 15975 for requirements.

2. RTU-2 Humidity Sensor: Provide field installed, wall-mounted or duct-mounted humidity sensor to control activation of the hot gas reheat dehumidification option.

3. Dual Thermistor Remote Zone Sensor: Provide this sensor to allow the owner to reduce the total number of remote sensors required to obtain space temperature averaging.

4. Motorized Outside Air Dampers. Refer to Specification Section 15975 for requirements.

5. Roof Mounting Curb: Unit shall be furnished with a minimum 14-inch high factory fabricated, vibration isolation, acoustical style solid bottom roof curb fully gasketed between the curb top and unit bottom with the curb. Coordinate curb height with Architectural to provide a minimum of 8" from finished roof to top of curb. Roof mounting curb shall be heavy gauge zinc coated steel with nominal two-inch by four-inch nailer setup. Supply/return air opening gasketing shall be provided. Curb shall ship knocked down for easy assembly. Channel shall be provided to allow for adjustment of return air opening location. Supply air and return air sections of the curb shall be divided and sealed air tight to allow the return section to be used as a return air plenum. Curb shall be manufactured to National Roofing Contractors Association guidelines.

PART 3  EXECUTION

3.1  INSTALLATION

A. Install units in strict accordance with Manufacturer’s instructions.

B. Confirm use of minimum 14" high curb and coordinate with Architectural to provide minimum 8" for top of finished roof to bottom of roof curb manufactured in accordance with the National Roofing Contractors Association guidelines.

C. Provide condensate drain line with trap per Manufacturer’s instructions and route to nearest plumbing drain or as shown on Plans.

1. Copper Tubing: ASTM B88, Type L, hard drawn.
   b. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2. Secure condensate drain pipe to pipe support. Slope to drain. Insulate per Section 15080 - Mechanical Insulation

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

Section includes metal ductwork, nonmetallic ductwork, plenums, kitchen hood exhaust duct, and duct cleaning.

1.2 DEFINITIONS

A. Primary Supply – In a variable air volume system, (VAV) the supply air duct from air handling unit outlet to terminal unit inlet.

B. Secondary Supply – In a variable air volume system, (VAV) the supply air duct from outlet of terminal unit to air distribution device.

1.3 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is 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.

B. Seal ductwork in accordance with ASHRAE 90.1-2004 and International Energy Conservation Code - 2003 standards and as described herein.

1.4 SUBMITTALS

A. Section 15010 – Mechanical General Conditions: Submittals.

B. Coordination Drawings: Indicate duct fittings, gages, sizes, welds, and configuration for all systems.

C. Product Data: Submit data for duct materials duct liner and duct connectors.

D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.5 CLOSEOUT SUBMITTALS

Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 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.

C. Materials: Flame spread / smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, UL 723.

1.7 QUALIFICATIONS

Installer: Company specializing in performing Work of this Section with minimum three (3) years documented experience.

1.8 FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 DUCT MATERIALS


B. Stainless Steel Ducts: ASTM A167, Type 304.

C. Fasteners: Rivets, bolts, or sheet metal screws.

D. Hanger Rod: ASTM A36; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

E. Sealant:
   1. Manufacturers / Product:
      a. Rector Seal / Air-Lock 181.
      b. Design Polymeric / DP 1020.
   2. Non-hardening, Non-flammable; water-based; fiber reinforced; mildew, water and U.V. resistant; compatible with mating materials; UL listed 181A or 181B; liquid used alone or with tape or heavy mastic.

F. General Purpose Fire Stopping Sealant (Refer to Architectural Sections):
   1. Manufacturers:
      a. 3M Model 2000.
      b. Spec Seal Model 100.
      c. Hilti.
   2. Water based, non-slumping, premixed sealant with intumescent properties, rated for three (3) hours per ASTM E814 and UL 1479.
2.2 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings. Furnish duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Construct Tees, 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.

C. Round ductwork in secondary supply and constant volume supply, return, outside air and exhaust systems shall be constructed with grooved seam pipe lock flat lock longitudinal seams (Refer to SMACNA 1997 Figure 3-1). Snap-lock seams are not acceptable.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round 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.

F. On rectangular ductwork provide standard 45 degree lateral wye takeoffs. When space does not allow 45 degree lateral wye takeoff, use 90 degree conical tee connections.

G. When air velocity exceeds 5000 fpm, provide metal nosing on leading edge of duct liner in accordance with SMACNA Standards, so that airflow does not dislodge liner from ductwork.

2.3 INSULATED FLEXIBLE DUCTS

A. Manufacturers:
   1. Flexmaster USA, Inc. Model 8m.
   2. ATCO.

B. UL 181, Class 1, CPE inner film without adhesive supported by helical wound spring galvanized steel wire, fiberglass insulation, aluminized vapor barrier film.
   1. Pressure Rating: 6 inches wg positive and 4.0 inches wg negative.
   3. Temperature Range: -20 degrees F. to 250 degrees F.

C. Acoustical performance, when tested by an independent laboratory in accordance with Air Diffusion Council’s Flexible Air Duct Test Code FD 72-R1, Section 3.0. Sound properties shall be as follows:
### Octave Band

<table>
<thead>
<tr>
<th>Octave Band</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hz.</td>
<td>125</td>
<td>250</td>
<td>500</td>
<td>1000</td>
<td>2000</td>
<td>4000</td>
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<tr>
<td>6&quot; diameter</td>
<td>7</td>
<td>31</td>
<td>40</td>
<td>38</td>
<td>40</td>
<td>27</td>
</tr>
<tr>
<td>8&quot; diameter</td>
<td>13</td>
<td>29</td>
<td>36</td>
<td>35</td>
<td>38</td>
<td>22</td>
</tr>
<tr>
<td>12&quot; diameter</td>
<td>21</td>
<td>28</td>
<td>29</td>
<td>33</td>
<td>26</td>
<td>12</td>
</tr>
</tbody>
</table>

### 2.4 SINGLE WALL ROUND DUCTS – SPIRAL

**A.** Manufacturers:

1. Spiral Pipe of Texas.
4. Semco.

**B.** Round spiral lock-seam duct with galvanized steel wall. Fittings to be spot welded and bonded, factory fabricated. Access doors to be pressure-relief style with insulated frame and door.

**C.** 90 degree elbows shall consist of not less than five (5) gores and 45 degree elbows shall consist of not less than three gores. All elbows 8" diameter and less may be die-formed longitudinally welded type with centerline radius not less than 1 1/2 times the duct diameter. Tees shall be 90 degree "Lo Loss" tee taps. Register taps shall be boot taps welded to spiral lock-seam duct. Duct fittings shall be factory fabricated. Shop or field fabricated duct fittings will not be accepted.

### 2.5 KITCHEN HOOD EXHAUST DUCTWORK

**A.** Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.

**B.** Construct of 16 gage carbon steel or 18 gage stainless steel using continuous external welded joints.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

Verify sizes of equipment connections before fabricating transitions.

#### 3.2 INSTALLATION

**A.** Duct sizes shown on Plans are inside clear dimensions. For lined ducts, maintain sizes inside lining.

C. Field verify all measurements and dimensions prior to fabrication of any ductwork. Notify engineer where duct sizes require modifications. No additional compensation will be awarded for modifications to fit field conditions.

D. Minor changes in duct routing and dimensions to avoid structural members and other obstructions will be allowed. Major departures from duct layout will require approval of the Owner’s representative.

E. Duct materials or prefabricated ductwork stored or installed at site shall be protected from weather, dust, and moisture. Damaged duct shall be removed and replaced at the Contractor’s expense.

F. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

H. Ductwork installed above inaccessible ceiling to have operable quadrants on balancing dampers.

I. Use double nuts and lock washers on threaded rod supports.

J. Connect flexible ducts to metal ducts with draw bands. Tape inner liner and insulation to metal duct.

K. Flexible ducts shall be installed in a fully extended condition free of sags and kinks, using only the minimum length required to make the connection.

L. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.

M. Sleeve wall openings at all wall louvers installed by Mechanical Division.

N. Seal openings in ducts where probes for TAB instruments are inserted.

O. All joints in spiral pipe and fittings shall be made using a sleeve type coupling, duct sealer, and duct tape. This shall consist of application of duct sealer to the male fitting, mechanically locking with a minimum of three (3) pop rivets or sheet metal screws for round duct and a minimum of six (6) pop rivets or sheet metal screws for oval duct, application of duct sealer to the outside of the joint to 2" width, and a single wrap of duct tape over the wet sealer. A minimum period of twenty-four (24) hours shall elapse after installation before attempting leakage test.
P. Firestopping: Seal around all duct penetrations through fire barriers with fire stopping sealant. Provide firedampers and smoke dampers as shown on Plans.

Q. Kitchen hood exhaust ducts: Use stainless steel for ductwork exposed to view and stainless steel or carbon steel where ducts are concealed. Install residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for clean out.

3.3 SEALING OF DUCTWORK

A. Seal ductwork, as a minimum, in accordance with ASHRAE 90.1-1999 and IECC 2003 requirements, and as required herein. All supply, return, and outside air duct shall be sealed as Class A and all exhaust duct shall be sealed as Class B, regardless of static pressure classification of system.
   1. Supply, return, and outside air: Seal all transverse joints, longitudinal seams, duct connections, and duct wall penetrations.
   2. Exhaust air: Seal all transverse joints, longitudinal seams and duct connections.
   3. Pressure-sensitive tape shall not be used as the primary sealant.

3.4 LEAKAGE TESTING

Before any external insulation is applied to ductwork, coordinate with TAB Contractor to perform leakage test in accordance with ASHRAE 90.1-1999 standards regardless of pressure classification. Where leakage exceeds maximum allowable rate, provide remedial work as necessary for compliance.

3.5 VERIFICATION OF MINIMUM GAUGES

Contractor shall be required to cut samples of materials from installed ductwork at five (5) locations as designated by Engineer prior to installation of insulation. Samples will be provided to Engineer for verification that gauges are in compliance with SMACNA standards and with minimum gauges as specified herein. If any sample is found not to be in compliance with Contract Documents, ductwork shall be replaced and an additional set of five samples shall be provided until it is determined that all ductwork is in compliance. Contractor shall patch ductwork where samples are taken. All ductwork found to be non-compliant shall be removed and replaced by Contractor at no expense to the Owner or Design Professionals.

3.6 INTERFACE WITH OTHER PRODUCTS

A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing and balancing 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 diffusers to low pressure ducts directly or with six (6) feet maximum length of insulated flexible duct held in place with strap or clamp.
C. Connect terminal units to supply ducts directly or with three foot maximum length of insulated flexible duct. Do not use flexible duct to change direction.

3.7 CLEANING

Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.8 SCHEDULES

**DUCTWORK MATERIAL SCHEDULE**

<table>
<thead>
<tr>
<th>AIR SYSTEM</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Supply Air-Round</td>
<td>Spiral lockseam galvanized steel</td>
</tr>
<tr>
<td>Primary Supply Air-Rectangular</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Secondary Supply Air</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Round and Rectangular</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Supply, Return, General Exhaust, Outside Air – Round &amp; Rectangular</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Kitchen Hood Exhaust</td>
<td>Stainless Steel, Carbon Steel</td>
</tr>
</tbody>
</table>

**DUCTWORK PRESSURE CLASS SCHEDULE**

<table>
<thead>
<tr>
<th>AIR SYSTEM</th>
<th>PRESSURE CLASS</th>
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</thead>
<tbody>
<tr>
<td>VAV Primary Supply</td>
<td>3 inch wg</td>
</tr>
<tr>
<td>VAV Secondary Supply</td>
<td>2 inch wg</td>
</tr>
<tr>
<td>Supply, Return, Exhaust</td>
<td>2 inch wg</td>
</tr>
</tbody>
</table>

**MINIMUM SHEET METAL GAUGES**

<table>
<thead>
<tr>
<th>Maximum Rectangular Duct Size Inches</th>
<th>U.S. Standard Gauges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 12</td>
<td>26</td>
</tr>
<tr>
<td>13 – 30</td>
<td>24</td>
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<tr>
<td>31 – 48</td>
<td>22</td>
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<tr>
<td>49 – 54</td>
<td>20</td>
</tr>
<tr>
<td>55 and above</td>
<td>18</td>
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</tbody>
</table>

** Ductwork must be reinforced in accordance with pressure class and SMACNA standard requirements.

<table>
<thead>
<tr>
<th>Maximum Round Duct Size Inches</th>
<th>U.S. Standard Gauges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 14</td>
<td>26</td>
</tr>
<tr>
<td>15 – 26</td>
<td>24</td>
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<td>27 – 36</td>
<td>22</td>
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<tr>
<td>37 – 50</td>
<td>20</td>
</tr>
<tr>
<td>51 and above</td>
<td>18</td>
</tr>
</tbody>
</table>
** Minimum duct gauges are selected for medium pressure spiral duct up to 10” inches static pressure and low pressure long seam up to 2” inches static pressure.

END OF SECTION
SECTION 15820
DUCT ACCESSORIES

PART 1  GENERAL

1.1  SUMMARY

Section includes back-draft dampers, duct access doors, fire dampers, volume control dampers, flexible duct connections, and duct test holes.

1.2  SUBMITTALS

A.  Section 15010 – Mechanical General Conditions: Submittals.

B.  Manufacturer’s Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.

C.  Manufacturer’s Certificate: Certify products meet or exceed specified requirements.

1.3  CLOSEOUT SUBMITTALS

A.  Project Record Documents: Record actual locations of access doors.

B.  Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.4  QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

1.5  DELIVERY, STORAGE, AND HANDLING

Protect dampers from damage to operating linkages and blades.

1.6  FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

1.7  WARRANTY

Furnish one (1) year manufacturer warranty for duct accessories.

1.8  EXTRA MATERIALS

Furnish two (2) of each size and type of fusible link.
PART 2  PRODUCTS

2.1 BACKDRAFT DAMPERS

A. Manufacturers:
   2. Greenheck.
   3. Philips.
   4. Safe-Air.


C. Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, galvanized 16 gage thick steel or extruded aluminum blades, maximum 6 inch width, center pivoted, with felt or 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 DUCT ACCESS DOORS

A. Manufacturers:
   1. Ruskin Model ADC/H series.
   2. Flexmaster.
   4. Philips.
   5. Safe-Air.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish double wall door with insulation to match R-value of adjacent ductwork.
   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 with outside and inside handles.
   4. Larger Sizes: Furnish additional hinge.
   5. Access panels with sheet metal screw fasteners are not acceptable.

2.3 FIRE DAMPERS

A. Manufacturers:
   1. Ruskin Model DIBD, CFD, FD-60 series.
   2. Greenheck.
   3. Philips.
   4. Safe-Air.
B. Fabricate in accordance with NFPA 90A and UL 555, and manufacturer's condition of listing. Dampers shall be dynamic type.

C. Ceiling Dampers: Galvanized steel, 22 gage frame and 16 gage flap, two layers 0.125 inch ceramic fiber on top side with locking clip. Provide radiation blanket on air device back pan.

D. Curtain Type Dampers: Galvanized steel with interlocking blades. Furnish stainless steel closure springs and latches for closure under airflow conditions. Configure with blades out of air stream except for 1.0-inch pressure class ducts up to 12 inches in height.

E. Airfoil Type Dampers: Galvanized steel with airfoil-shaped blades. Furnish stainless steel closure springs and latches for closure under airflow conditions.

F. Leakage Rating: Class 1.

G. Fire Resistance Rating: 1 1/2 or 3 hour as indicated on Drawings.

H. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

I. Sleeve: Mount damper in integral factory fabricated steel sleeve. Duct-to-sleeve connection to be breakaway type.

2.4 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   1. Ruskin Model FSD-60 series.
   2. Greenheck.
   3. Philips.
   4. Safe-Air.

B. Fabricate in accordance with NFPA 90A, UL 555, and UL 555S.

C. Multiple-Blade Dampers with Airfoil Blades: Fabricate with 16 gage galvanized steel frame and blades. Furnish oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.

D. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Locate damper operator on exterior of duct and link to damper operating shaft. Meet with Uniform Building Code 15 second operation requirements.

E. Electric Fuse Link: Electronic thermal sensing device interrupts power supply at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled, automatically resettable. Provide TS150 firestat with electric interface for
override by dynamic smoke management system or tie into building Fire
Alarm System (refer to Division 16).


G. Leakage Rating: Class 1.

H. Fire Resistance Rating: 1 1/2 or 3 hour as required.

I. Sleeve and Retaining Angles: Mount damper in integral factory fabricated
steel sleeve. Duct-to-sleeve connection to be breakaway type.

2.5 VOLUME CONTROL DAMPERS

A. Manufacturers:
   1. Ruskin Model MD15, MDRS 25.
   2. Greenheck.
   3. Philips.
   4. Safe-Air.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards -
Metal and Flexible, and as indicated on Drawings.

C. 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.

D. Round Damper: Fabricate of 20 gauge galvanized steel with 14 gauge
butterfly damper blade, neoprene seal, and stainless steel sleeve bearing.

E. End Bearings: Except in round ductwork 12 inches 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.
   4. On dampers concealed above inaccessible ceiling, provide concealed
damper regulators as manufactured by Young Regulator, Model 315,
927, 1200. In finished areas where appearance of instrument port is
unacceptable, provide remote cable control as manufactured by
Young Regulator, Model Bowden Cable Control.

G. Velocity and pressure rating of damper to match duct system characteristics
   at installed location.
2.6 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
   1. Durodyne Model Therma Fab.
   2. Vent Fab.
   3. Elgen.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Connector: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
   3. Metal: 3 inch wide, 24 gage galvanized steel.

2.7 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 15810 - Ducts for duct construction and pressure class.

B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.

C. Install duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and as indicated on Drawings. Install minimum 8 x 8 inch size for hand access, 24 x 24 inch size for shoulder access, and as indicated on Drawings. Review locations prior to fabrication.

D. Install duct test holes where indicated on Drawings and required for testing and balancing purposes.

E. Provide fire dampers and combination fire and smoke at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings, and hinges.

F. Install fire dampers in accordance with NFPA 92A.
G. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment and supported by vibration isolators.

H. Install balancing dampers a minimum of two (2) equivalent duct diameters from duct takeoff.

3.2 DEMONSTRATION AND TRAINING

Demonstrate re-setting of fire dampers to Owner's Representative.

END OF SECTION
SECTION 15830
FANS

PART 1 GENERAL

1.1 SCOPE

This Section provides for the furnishing and installation of fans with all supplemental equipment.

1.2 APPLICABLE PROVISIONS

Refer to Section 15010 - Mechanical General Conditions.

1.3 PERFORMANCE

A. Provide fan type, arrangement, rotation, capacity, size, motor horsepower, and motor voltage as scheduled on the Drawings.

B. Rate fans according to appropriate Air Moving and Conditioning Association, Inc. (AMCA), approved test codes and procedures. Supply fans with sound ratings below the maximums permitted by AMCA standards. All fans provided must be licensed to bear the Certified Ratings Seal.

C. Statically and dynamically balance all fans.

1.4 SUBMITTALS

A. Submit product data on all fans, including cut sheets, fan curve, sound data, performance data, and accessories provided.

B. On products required to have a paint finish, submit a detailed cut sheet of paint properties.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Centrifugal Fans:
   1. Loren Cook.
   2. Greenheck.
   3. Acme.
   4. ILG.
   5. Twin City.

2.2 SUPPLEMENTAL EQUIPMENT

A. Motor Covers: Furnish weatherproof motor covers for installation outdoors in inclement weather. Apply the same finish as used on the fan.
B. Belt Drives:
1. Unless otherwise specified for belt-driven fans, equip the fan motors with variable pitch sheaves. Select the sheave size for the approximate midpoint of adjustment and to provide not less than 20 percent speed variation from full open to full closed size drives for 150-percent of rated horsepower. Key the fan sheave to the fan shaft.
2. Nonadjustable motor sheaves may be used for motor sizes over 15 horsepower, at the Contractor’s option. However, if changing a nonadjustable sheave becomes necessary to produce the specified capacity, the change must be made at no additional cost.
3. Furnish belt guards and apply the same finish as used for the fan.

C. Safety Disconnect Switch: Furnish a factory-wired, safety disconnect switch on each unit.

D. Prefabricated Roof Curbs: Furnish prefabricated roof curbs with built in cant strips and lined with glass fiber insulation. Curbs shall be 0.063-inch aluminum. The minimum height is 14 inches. Coordinate with Architect to provide minimum 8" to top of curb above finished roof. Include on each roof curb a resilient pad for equipment mounting on the top flange. Match curb to roof pitch where applicable.

2.3 ROOFTOP CENTRIFUGAL FANS

A. Fan shall be a spun aluminum, roof mounted, belt or direct driven (as scheduled), up or down-blast centrifugal exhaust ventilator. Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

B. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections. Bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust air stream. Unit shall bear an engraved aluminum nameplate with manufacturer’s data.

C. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision-machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

D. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.
E. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

F. Belts shall be oil and heat resistant, non-static type. 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.

G. Accessories: Provide the following accessories as indicated on the schedule:
   1. All aluminum construction.
   2. Stainless steel hardware.
   3. Roof curb.

2.4 DOWN-BLAST KITCHEN SUPPLY FAN

A. Unit shall be of internal frame type construction of galvanized steel. All frames and panels shall be G90 galvanized steel. All metal-to-metal surfaces exposed to the weather shall be sealed, requiring no caulking at job site. All components shall be easily accessible through removable panels. Fan shall be belt driven.

B. Centrifugal fans shall be double width, double inlet. Fan and motor shall be mounted on a common base and shall be internally isolated. All blower wheels shall be statically and dynamically balanced. Ground and polished steel fan shafts shall be mounted in permanently lubricated ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged speeds.

C. Motors shall be energy efficient, complying with EPACT standards, for single speed ODP and TE enclosures. Motors shall be permanently lubricated, heavy duty type, matched to the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be cast and have machined surfaces. Units with motors of 10 HP and less shall be supplied with an adjustable drive pulley.

D. Filters shall be mounted in a straight or V-bank arrangement. Filters shall be UL Class 2, 2 inch aluminum mesh and easily removable.

E. Weatherhood shall be constructed of G90 galvanized steel and include 2 inch aluminum mesh filters at the intake.

F. Accessories: Provide the following accessories as indicated on the schedule.
   1. All Aluminum Construction.
   2. Stainless steel hardware.
   3. Roof curb.
5. Intake extension (length to maintain minimum 10’-0” separation from any exhaust/roof vent outlets).

2.5 UP-BLAST KITCHEN EXHAUST FAN

A. Fan shall be a spun aluminum, roof mounted, belt driven, up-blast centrifugal exhaust ventilator, suitable for exhausting grease laden air.

B. Fan shall be listed by Underwriters Laboratories (UL 762). Fan shall bear the AMCA certified ratings seal for sound and air performance.

C. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The wind-band shall have a rolled bead for added strength. A two piece top cap shall have quick release latches to provide access into the motor compartment. An external wiring compartment with integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. A one inch thick, three pound density foil backed heat shield shall be utilized to protect the motor and drive components from excessive heat. Unit shall bear an engraved aluminum nameplate.

D. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

E. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.

F. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty re-greasable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

G. Belts shall be oil and heat resistant, non-static type. 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.
H. Accessories:
1. Vented extension.
2. Grease trough.
3. Hinged curb cap.
4. External NEMA 3R Disconnect Switch – Pre-wired.
5. Provide factory applied baked phenolic coating with UV protectant on casing, shroud and fan wheel.

PART 3 EXECUTION

3.1 Install fans according to the manufacturer’s instructions and in the locations shown on the Drawings.

3.2 Provide flexible connection at inlet and outlet for fans.

3.3 Roof mounted fans shall be installed on roof curbs provided by the fan manufacturer.

3.4 On roof mounted fans, electrical wiring and/or conduit shall not interfere with backdraft damper.

END OF SECTION
SECTION 15840
AIR TERMINAL UNITS

PART 1  GENERAL

1.1  SUMMARY

Section includes constant and variable volume terminal units, fan powered terminal units, integral heating coils, integral damper motor operators, and integral controls.

1.2  REFERENCES


B. UL 181 (Underwriters Laboratories, Inc.) - Factory-Made Air Ducts and Connectors.

1.3  SUBMITTALS

A. Section 15010 – Mechanical General Conditions: Submit.

B. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.

C. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.

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

1.4  CLOSEOUT SUBMITTALS

A. Record actual locations of units and controls components.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

1.5  QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

B. Installer: Company specializing in performing work of this Section with minimum three (3) years documented experience.
1.6 FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

1.7 COORDINATION

Section 15010 – Mechanical General Conditions. Coordinate with other Divisions and Owner’s Representative.

PART 2 PRODUCTS

2.1 AIR TERMINAL UNITS

A. Manufacturers:
   1. Titus.
   2. Nailor.
   5. Substitutions: Section 15010 – Mechanical General Conditions.

B. Ceiling mounted variable air volume and constant supply air control terminals for connection to single duct, central air systems, with electronic controls, and electric heating coils.

C. Identify each terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.

D. Filter Rack: 1" filter rack with hinged, lockable retainer. "Bend tabs" not acceptable.

2.2 SINGLE DUCT VARIABLE VOLUME UNITS – Pressure Independent

A. Basic Assembly:
   2. Lining: Internally lined. Minimum 1/2 inch thick with non-porous, sealed insulation, 1½ lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. All cut edges must be sealed from the airstream using mechanically bonded metal barrier strips. Liners made of Mylar, Tedlar, Silane or woven fiberglass cloth are not acceptable. Insulation shall be equivalent to Titus Steri-ILoc or double wall lining is acceptable.
   3. Plenum Air Inlets: S slip and drive connections for duct attachment.
   5. Provide primary airflow balancing connection.
   6. Damper operation shall be pressure independent.
B. Basic Unit:
2. Volume Damper: Construct of galvanized steel with peripheral gasket and Delrin or bronze oilite self-lubricating bearings; maximum damper leakage: Two (2) percent of design air flow at two (2) inches inlet static pressure. Nylon bearings are not acceptable.
3. Mount damper operator to position damper normally open.

C. Electric Heating Coil:
1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
   a. Primary and secondary over-temperature protection.
   b. Minimum airflow switch.
   c. All safety options.
   d. SCR capacity control.


E. Velocity Sensor: Multipoint, center averaging inlet velocity sensor.

F. Wiring:
1. Factory mount and wire controls. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.
2. Factory mount transformer for control voltage on electric and electronic control units. Furnish terminal strip in control box for field wiring of thermostat and power source.
4. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Division 16.

G. Controls: VAV controller to be furnished by Controls Contractor to VAV manufacturer’s facility and factory installed by VAV manufacturer. Refer to Specification Sections 15975 – Direct Digital Controls System and 15985 – Sequence of Operation.

2.3 FAN POWERED VARIABLE VOLUME UNITS – SERIES OR PARALLEL, PRESSURE DEPENDENT

A. Basic Assembly:
2. Lining: Internally lined. Minimum 1/2 inch thick with non-porous, sealed insulation, 1½ lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. All cut edges must be sealed from the airstream using mechanically bonded metal barrier strips. Liners made of Mylar, Tedlar, Silane or woven fiberglass cloth.
are not acceptable. Insulation shall be equivalent to Titus Steri-ILoc or double wall lining is acceptable.

3. Plenum Air Inlets: Round stub connections and S slip and drive connections for duct attachment.
5. Provide bottom access panel for servicing of damper and fan motor.
6. Provide primary airflow balancing connection.
7. Damper operation shall be pressure independent.

B. Basic Unit:
1. Configuration: Air volume damper assembly and fan in series or in parallel arrangement inside unit casing as scheduled on drawings. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and Delrin or bronze oilite self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 2 inches inlet static pressure. Nylon bearings are not acceptable.
3. Mount damper operator to position damper normally open.

C. Automatic Damper Operator: Electric Actuator: 24 volt with remote temperature read and reset capability. Must be capable of supplying 35 in-lb of torque.

D. Fan Assembly:
1. Fan: Forward curved centrifugal type with direct drive permanent-split-capacitor type, thermally protected motor. Refer to Division 16.
2. Speed Control: SCR controller with minimum voltage stop for infinitely adjustable speed control.

E. Velocity Sensor: Multipoint, center averaging inlet velocity sensor.

F. Electric Heating Coil:
1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
   a. Primary and secondary over-temperature protection.
   b. Minimum airflow switch.
   c. All safety options.
   d. SCR capacity control.

G. Wiring:
1. Factory mount and wire controls. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.
2. Factory mount transformer for control voltage on electric and electronic control units. Furnish terminal strip in control box for field wiring of thermostat and power source.
4. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Division 16.

H. Controls:
1. VAV controller to be furnished by Controls Contractor to VAV manufacturer’s facility and factory installed by VAV manufacturer. Refer to Specification Sections 15975 and 15985.
2. Electronic Controls: Contain in NEMA-1 enclosure with access panel sealed from airflow and mounted on side of unit. Factory mount controls to accomplish the specified sequence of operation.

I. Accessories: Terminal units marked DTFS-F shall have a factory installed integral inlet sound attenuator.

PART 3 EXECUTION

3.1 INSTALLATION

A. Connect to ductwork in accordance with Section 15810 - Ducts.

B. Install with required clearances for maintenance.

C. Install ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure. Do not support from adjacent ductwork.

3.2 ADJUSTING

Section 15990 - Testing, Adjusting, and Balancing.

END OF SECTION
SECTION 15850
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Diffusers.
B. Registers/Grilles.
C. Louvers.
D. Roof Hoods.

1.2 RELATED SECTIONS

A. Section 15810 – Ducts.
B. Section 15820 – Duct Accessories.
C. Section 15990 – Testing, Adjusting, and Balancing.
D. All Divisions of Contract Documents.

1.3 REFERENCES

B. AMCA 500 - Test Method for Louvers, Dampers, and Shutters.
C. ARI 650 - Air Outlets and Inlets.
E. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
F. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS

A. Section 15010 – Mechanical General Conditions: Submittals.

B. 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.
1.5 PROJECT RECORD DOCUMENTS
   A. Submit under provisions of Section 15010 – Mechanical General Conditions.
   B. Record actual locations of air outlets and inlets.

1.6 QUALITY ASSURANCE
   A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
   B. Test and rate louver performance in accordance with AMCA 500.

1.7 QUALIFICATIONS
   Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

PART 2 PRODUCTS

2.1 AIR DEVICES
   Refer to Specification Section 15820 and the Air Device Schedule on the Drawings for fire damper requirements.

2.2 RECTANGULAR CEILING DIFFUSERS
   A. Manufacturers:
      1. Titus Model TMS or as shown on Plans.
      2. Other acceptable manufacturers offering equivalent products:
         a. J&J.
         b. Metalaire.
         c. Krueger.
         d. Price.
   B. Type: Square, stamped, three core diffuser. Diffuser collar shall project not more than one inch (25 mm) above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque. In suspended lay-in ceilings, provide 24” x 24” lay-in panel.
   C. Fabrication: Steel construction with baked enamel white finish except as indicated on plans. Coordinate color with Architect prior to ordering.

2.3 CEILING DIFFUSERS
   A. Manufacturers:
      1. Titus Model TDC or as shown on Plans.
      2. Other acceptable manufacturers offering equivalent products:
         a. J&J.
         b. Metalaire.
c. Krueger.
d. Price.

B. Type: Square and rectangular, multi-louvered diffuser to discharge air in four way pattern except as indicated on Plans.

C. Frame: Surface mount, Lay-in, Inverted T-bar or as indicated on Plans.

D. Fabrication: Steel with baked enamel white finish as indicated on Drawings. Coordinate color with Architect prior to ordering.

E. Provide discharge pattern as indicated on Drawings.

2.4 WALL SUPPLY REGISTERS/GRILLES

A. Manufacturers:
   1. Titus Model 272 RS or as indicated on Plans.
   2. Other acceptable manufacturers offering equivalent products:
      a. J&J.
      b. Metalaire.
      c. Krueger.
      d. Price.

B. Type: Solid core, contoured airfoil, individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, double deflection

C. Frame: 1-1/4 inch margin with concealed mounting and gasket.

D. Fabrication: Steel with factory baked enamel white finish or as indicated on Drawings. Coordinate color with Architect prior to ordering.

2.5 CEILING SUPPLY GRILLES

A. Manufacturers:
   1. Titus Model PAR or as shown on plans.
   2. Other acceptable manufacturers offering equivalent products:
      a. J&J.
      b. Metalaire.
      c. Krueger.
      d. Price.

B. Type: Perforated face, 3/16 inch diameter holes on 1/4 inch staggered centers and no less than 51% free area.

C. Fabrication: Steel with baked enamel white finish except as indicated on plans. Coordinate color with Architect prior to ordering.
2.6 LINEAR SLOT DIFFUSERS

A. Manufacturers:
   1. Cook Model ML.
   2. Other acceptable manufacturers offering equivalent products:
      a. Price.
      b. Metalaire.
      c. Krueger.
      d. Price.

B. Type: Modulinear diffuser with ice tong pattern designed for supply. Direction (180 degrees from face of diffuser) and volume of the discharge air shall be adjustable.

C. Frame: Heavy gauge extruded aluminum. Provide alignment pins where multiple sections are used to give a continuous slot appearance.

D. Fabrication: Extruded aluminum with steel pattern controllers. Heavy gauge extruded aluminum end borders, end caps and mitered corners shall be available to close out the ends of the diffusers.

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, remote operable.

F. Plenums shall be manufactured by diffuser manufacturer and shall not be field fabricated except as required by field conditions. Line with 1” acoustical insulation in addition to external wrap.

2.7 RETURN/EXHAUST REGISTERS/GRILLES

A. Manufacturers:
   1. Titus Model 350 RL or as shown on Plans.
   2. Other acceptable manufacturers offering equivalent products:
      a. J&J.
      b. Metalaire.
      c. Krueger.
      d. Price.

B. Blades: 3/4 inch minimum depth, 3/4 inch maximum spacing, fix deflection, vertical face, double deflection.

C. Frame: 1-1/4 inch margin with concealed mounting and gasket.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades with factory white baked enamel finish or as indicated on Drawings. Coordinate color with Architect prior to ordering.

PART 3 EXECUTION

3.1 PREPARATION
Coordinate work of this Section with other affected work.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. 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.

E. Paint ductwork visible behind air outlets and inlets matte black.

END OF SECTION
SECTION 15860
AIR CLEANING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

Disposable, extended area panel filters and filter gages.

1.2 REFERENCES

A. ARI 850 - Commercial and Industrial Air Filter Equipment.


C. UL 900 - Test Performance of Air Filter Units.

1.3 PERFORMANCE TOLERANCES

Conform to ASHRAE 52.2-1999.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 15010 – Mechanical General Conditions.

B. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.

1.5 EXTRA MATERIALS

Provide MERV-8 disposable panel filters during construction. Periodically inspect temporary construction filters and change out when dirty or as directed by manufacturer’s recommendations whichever comes first. If, in the opinion of the Owner’s Representative, the temporary construction filters require changing, then the filters shall be changed out with clean filters at no additional cost to the Owner. Provide one clean set of MERV 8 for air balance, and one spare set of MERV 8 to owner at project completion. Clean coils free of dirt and debris at the end of construction. Complete cleaning before commissioning of equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Farr Company.

B. Cambridge Filter Corporation.

C. American Air Filter.
2.2 DISPOSABLE, EXTENDED AREA PANEL FILTERS

A. Manufacturer: American Air Filter.

B. Media: UL 900 Class 2, pleated, lofted, non-woven, reinforced cotton and synthetic fabric; supported and bonded to welded wire grid.
   1. Frame: Cardboard.
   2. Nominal Thickness: 2 inches.

C. Rating, ASHRAE 52.2: MERV 8.

2.3 FILTER GAGES

A. Manufacturers:
   1. Dwyer.
   2. Trerice.

B. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case. Furnish vent valves, black figures on white background, front calibration adjustment, range 0-2.0 inch wg, 2 percent of full scale accuracy.

C. Accessories: Static pressure tips with integral compression fittings, 1/4 inch plastic tubing, 2-way or 3-way vent valves.

PART 3 EXECUTION

3.1 PREPARATION

Coordinate work of this Section with other affected work.

3.2 INSTALLATION

A. Install air-cleaning devices in accordance with manufacturer's instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

D. Install filter gage static pressure tips upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level.

END OF SECTION
PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 15 Sections as applicable. Refer to other Divisions for coordination of work with other trades as required.

1.2 SYSTEM DESCRIPTION

A. The scope shall include all Variable Frequency Drive unit supports and all appurtenances. This Specification shall cover a complete adjustable frequency motor drive consisting of a pulse width modulated (PWM) inverter, for optimized motor/control efficiency and control of motor voltage and frequency for required motor torque. No special or custom AC motors will be required. The drive shall be manufactured in the USA, and be manufactured specifically for variable torque HVAC applications. System shall include:
   1. Sales Representative - exclusively for HVAC products with expertise in HVAC systems and controls.
   2. Independent service organizations.
   3. Local parts and service available to the installation site.

1.3 REFERENCES

A. NFPA 70 – National Electrical Code.


C. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).


E. Underwriters Laboratories. UL508C.

F. National Electrical Manufacturer’s Association (NEMA). ICS 7.0, AC Adjustable Speed Drives.

G. IEC 16800 Parts 1 and 2.

1.4 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.
B. All equipment and materials shall be installed in a workmanlike manner by experienced mechanics and as recommended by the manufacturer.

1.5 SUBMITTALS

A. Submit under provisions of Section 15010 – Mechanical General Conditions.

B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

C. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

D. Test Reports: Indicate field test and inspection procedures and test results.

E. Manufacturers Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Manufacturers Field Reports: Indicate start-up inspection findings.

1.6 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 15010 – Mechanical General Conditions.

1.7 OPERATION AND MAINTENANCE DATA

A. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

B. Maintenance Data: Include routine preventive maintenance schedule.

1.8 QUALIFICATIONS

VFD’s and options shall be UL listed as a complete assembly. VFD’s that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. The VFD shall be UL listed for 100 KAIC.

1.9 REGULATORY REQUIREMENTS

Conform to requirements of NFPA 70.
1.10 COMMUNICATION PROTOCOL
VFD shall be Bac-Net or Lon-Works based to communicate with DDC system.

1.11 DELIVERY, STORAGE, AND HANDLING
A. Accept controllers on site in original packing. Inspect for damage.
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 in accordance with manufacturer’s written instructions. Lift only with lugs provide for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.12 FIELD MEASUREMENTS
Verify that field measurements are as indicated on shop drawings.

1.13 MAINTENANCE SERVICE
Furnish service and maintenance of controller for one (1) year from Date of Substantial Completion.

1.14 EXTRA MATERIALS
A. Provide two (2) of each air filter.
B. Provide three (3) of each fuse size and type.

1.15 START–UP
Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the Owner, and a copy kept on file at the manufacturer.

1.16 PRODUCT SUPPORT
Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.

1.17 WARRANTY
Warranty shall be twenty-four (24) months from the date of substantial completion. The warranty shall include all parts, labor, travel time, and expenses. There shall be 365/24 support available via a toll free phone number.
PART 2  PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. ABB Power Distribution, Inc.
   2. Toshiba.
   3. Danfoss.
   4. Alternate Manufacturers: Section 15010 – Mechanical General Conditions.

2.2 MOTOR CONTROLLERS, GENERAL

A. Coordinate the features of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, the duty cycle of the motor, drive, and load, and the pilot device, and control circuit affecting controller functions. Provide controllers that are horsepower rated to suit the motor controlled.

B. Contacts shall open each ungrounded connection to the motor.

C. Overload Relays: Ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of the specific motor to which connected with appropriate adjustment for duty cycle.

D. Enclosures: For individually mounted motor controllers and control devices, comply with NEMA Standard 250, “Enclosures for Electrical Equipment (1000 Volts Maximum).” Provide enclosures suitable for the environmental conditions at the controller location. NEMA Type 1 enclosures except as otherwise indicated.

2.3 SOLID-STATE, VARIABLE-SPEED MOTOR CONTROLLERS

A. General: Provide microprocessor based pulse width modulated controller listed and labeled as a complete unit and arranged to provide variable speed of a standard NEMA Design B, 3-phase, induction motor by adjusting output voltage and frequency of controller. Controller shall be designed and rated by the manufacturer for the type of load (e.g., fans, blowers, etc.) with which used. Controller shall also be approved by the manufacturer for the type of connection used between the motor and load (direct connection or power transmission connection).

B. Isolation Transformer: 1-to-1 ratio, with capacity coordinated by the manufacturer for the controller, motor, drive, and load combination.

C. Ratings: As follows:
   1. Output Rating: 3-phase, 6 to 60 Hz, with voltage proportional to frequency throughout the voltage range.
   2. Starting Torque: 100 percent of rated torque, or as indicated.
3. Speed Regulation: Plus or minus 1 percent.
4. Ambient Temperature: 0 deg C to 40 deg C.
5. Efficiency: 95 percent minimum at full load, 60 Hz.

D. Isolated control interface to allow the controller to follow one of the following over an 11:1 speed range:
   1. Electrical Signal: 4 to 20 milliamps at 24 V.
   2. Electrical Signal: 0 to 10 V.

E. Internal Adjustability: Provide the following internal adjustment capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum RPM.
   2. Maximum Speed: 50 to 100 percent of maximum RPM.
   3. Acceleration: 2 to 22 seconds.
   4. Deceleration: 2 to 22 seconds.
   5. Current Limit: 50 to 110 percent of maximum rating.

F. Self-protection and reliability features shall include:
   1. Input transient protection by means of surge suppressors.
   2. Snubber networks to protect against malfunction due to system voltage transients.
   5. Instantaneous Overcurrent Trip.
   7. Reverse Phase Protection.
   10. Short Circuit Protection.

G. Automatic Reset/Restart: Attempt three (3) restarts after controller fault or on return of power to the system following an interruption and before shutting down for manual reset or fault correction. Provide for restarting during deceleration without damage to the controller, motor, or load.

H. Power Interruption Protection: Prevent motor reenergizing after a power interruption until motor has stopped.

I. Interlocks: Provide normally open auxiliary open contact.

J. Operation and maintenance features shall include:
   1. Status Lights: Door-mounted LED indicators to indicate power on, run, overvoltage, line fault, overcurrent, and external fault.
   3. Current-Voltage-Frequency Indicating Devices: Mount meters or digital readout device and selector switch flush in controller door and connect to indicate controller output.
   4. Bypass: Two contactor bypass shall operate manually or automatically to bypass power around the variable frequency drive.
upon drive failure. Electronic bypass shall be located next to the drive in a side by side configuration and consist of a bypass motor starter and electronic control components. Electronic bypass shall have the following basic features:

a. Motor overload protection.
b. Lose of phase protection.
c. User interface panel.
d. Connection to fire alarm system for shut down.
e. Connection to duct mounted manual reset high pressure switch.

5. Integral Main Disconnect Switch or Circuit Breaker: Switch or breaker shall be connected to door mounted control lever handle. Door shall lock when drive power is on and unlock when drive power is off. Drive door must not be allowed to open when power is on.

6. Drive Overcurrent Protection: Provide overcurrent protection through circuit breaker or fuses at the line power side before the drive.


8. Provide maintenance service switch (drive isolation mechanical only disconnect).

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surface is suitable for controller installation.

B. Do not install controller until building environment can be maintained within the service conditions required by the manufacture.

3.2 PREPARATION

Provide concrete housekeeping pad as indicated on Drawings.

3.3 INSTALLATION

A. Install variable frequency drives as recommended by the unit manufacturer and as shown on the Drawings.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Install fuses in fusible switches.

D. Select and install overload heater elements in motor controllers to match installed motor characteristics.

E. Provide engraved plastic nameplates.
F. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.4 CONTROL WIRING

A. Install wiring between motor control devices and controlled devices as required and necessary and per Manufacturer’s recommendations.

B. Install wiring in conduit.

3.5 FIELD QUALITY CONTROL

Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

3.6 TESTING

A. Perform the following accordance with Manufacturer’s recommendations:
   1. Insulation Resistance – Resistance less than 100 meg-ohms is not acceptable.
   2. Trip Characteristics – Within Manufacturer’s published time-current tolerances.
   3. Auxiliary Protective Features – Loss of phase, phase imbalance and under voltage, etc.
   4. Improper Voltage - At terminals in controllers that have external control wiring when controller disconnect is opened. Any voltage over 30 V is unacceptable.

B. Correct deficiencies and retest motor control devices. Verify by the system tests that specified requirements are met.

3.7 CLEANUP

Remove dirt and debris before starting. Touch up paint as required and necessary. Clean devices internally using methods and materials as recommended by Manufacturer.

3.8 INSTRUCTION

A. Provide factory service representative to demonstrate variable frequency drive use and operation.

B. Schedule training with a minimum of seven (7) days notice.

END OF SECTION
SECTION 15975
DIRECT DIGITAL CONTROL SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers direct digital control (DDC) system software and router/building supervisor equipment. Devices and equipment specified shall form a comprehensive digital control system capable of performing all of the functions required in these Specifications, related project input/output and design intent documents, and the Sequence of Operations.

B. Existing campus-wide facility control system coordination: The intent of this project is to integrate the digital control system provided in this scope of work with the existing campus wide Facility Management System. Coordination with the Schneider Electric, Energy Solutions, Automation Engineering Team is required prior to bidding (972-323-5385). Coordinate all equipment, software, programming, etc. required to utilize and integrate with the existing Facility Management System.

C. The intent of this specification is to provide a networked, stand-alone (if network were to fail), distributed control system for building mechanical systems. The direct digital control system will consist of router/gateway devices, and shall support microprocessor based control units, panels, instrumentation, end control devices, wiring, piping, and related systems described in the accompanying specification sections.

D. The existing workstation and router shall communicate over Ethernet via common media consistent with the Owner’s LAN/WAN infrastructure. The communication shall support I/P protocol and network segmentation. The router shall support communication with an open architecture subnet system that utilizes EIA standard 709.1, the LonTalk protocol, as the common communication protocol or an RS-485 implementation of the ASHRAE Standard 135-2004 – BACnet. For the LonTalk implementation, the network manager shall be LNS (LON Network Services). Coordinate BACnet or LNS requirement with existing Facility Management System.

E. The DDC system subcontractor will provide a licensed copy of the software tool used to create the application and all files created by the software tool during the creation and commissioning of the application.

F. Controls contractor shall communicate with the package rooftop equipment manufacturer to determine network interface communication protocol requirements.

1.2 PRE-APPROVED MANUFACTURERS

A. Due to the Owner’s program to standardize the temperature control system at all the buildings on campus, the acceptable manufacturer and system model for the
process control units, terminal controllers and all other DDC system equipment is limited to Schneider Electric TAC. Subject to compliance with requirements, provide products by the following pre-qualified manufacturer:

2. Electronic Components: Schneider-Electric Field Devices.
3. Direct Digital Control Systems Devices: Schneider-Electric I/A BACnet or LON series, Continuum BACnet series, TAC Xenta LON series installed by approved manufacturer’s local field office.

B. The manufacturer must meet the below requirements:
1. The local office as well as the factory office will be ISO 9000 certified.
2. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of open protocol (LonWorks or BACnet based) systems as specified herein and must have been so for a minimum of three (3) years.
   a. The DDC system equipment will be installed by a manufacturer’s licensed and authorized distributor or a directly owned office. The installer’s office will be located no further than 200 miles from the facility to insure prompt service response.

PART 2 PRODUCTS

2.1 SYSTEM ARCHITECTURE

A. General:
1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), existing Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single existing Workstation simultaneously for operations and engineering tasks.
3. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, utilize the existing Reports Server installed on a Microsoft Windows based computer.
4. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, LonWorks IP, and/or Modbus TCP protocol. A sub-network of SDCUs using the BACnet MS/TP, LonTalk FTT-10A, and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

B. TCP/IP Level: The TCP/IP layer connects the building on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.
C. Fieldbus Level with Standalone Digital Control Units (SDCUs):
   1. The fieldbus layer shall be support all of the following types of SDCUs (coordinate with the existing Facility Management System):
      a. BACnet SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 50 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2007
      b. LonWorks SDCU requirements: The system shall consist of one or more LonWorks FTT-10A field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer shall consist of up to 50 SDCUs using peer-to-peer, event-driven communication for operation of HVAC and lighting equipment.
      c. Modbus SDCU requirements: The system shall consist of one or more Modbus RTU (RS-485 or RS-232) field buses managed by the Network Server Controller. The field bus layer shall consist of up to 240 SDCUs for operation of HVAC, power metering, and lighting equipment.

D. BAS LAN Segmentation: The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

E. Standard Network Support: All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC’s, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner’s Information Systems Department as all devices utilize standard TCP/IP components.

F. System Expansion:
   1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
   2. Web-based operation shall be supported directly by the NSCs and require no additional software, other than a Java supported network browser.
   3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

G. Support For Open Systems Protocols: All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks IP, LonWorks FTT-
10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.2 OPERATOR WORKSTATION REQUIREMENTS

A. General:
   1. The operator workstation portion of the BAS shall consist of one or more existing full-powered configuration and programming workstations, and one or more web-based operator workstations.
   2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
   3. All configuration workstations shall be personal computers operating under the Microsoft Windows 7 operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
   4. A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. Web-Based Operator PC Requirements:
   1. Any user on the network can access the system, using the following software:
      b. Internet Explorer 8.0 and above.
      c. Firefox x.x and above.
      d. Java-enabled.

C. Existing General Administration and Programming Workstation Software
   1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
   2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
   3. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

D. User Interface: The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any
workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

E. User Security: The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.

F. Configuration Interface:
1. The workstation software shall use a familiar Windows Explorer-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.

2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

G. Color Graphic Displays:
1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering
2. Requirements of the color graphic subsystem include:
   a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
   b. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
   c. The editor shall use Scalable Vector Graphics (SVG) technology.
   d. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
   e. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
   f. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
   g. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
   h. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.

3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
   a. Create and save pages.
   b. Group and ungroup symbols.
   c. Modify an existing symbol.
   d. Modify an existing graphic page.
   e. Rotate and mirror a symbol.
   f. Place a symbol on a page.
   g. Place analog dynamic data in decimal format on a page.
   h. Place binary dynamic data using state descriptors on a page.
   i. Create motion through the use of animated .gif files or JavaScript.
   j. Place test mode indication on a page.
   k. Place manual mode indication on a page.
   l. Place links using a fixed symbol or flyover on a page.
   m. Links to other graphics.
   n. Links to web sites.
   o. Links to notes.
   p. Links to time schedules.
   q. Links to any .exe file on the operator work station.
   r. Links to .doc files.
   s. Assign a background color.
   t. Assign a foreground color.
   u. Place alarm indicators on a page.
v. Change symbol/text/value color as a function of an analog variable.

w. Change a symbol/text/value color as a function of a binary state.

x. Change symbol/text/value as a function of a binary state.

y. All symbols used by Schneider Electric Buildings Business in the creation of graphic pages shall be saved to a library file for use by the owner.

H. Automatic Monitoring: The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

I. Alarm Management:
   1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
   2. Alarm management features shall include:
      a. A minimum of 1000 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
      b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
      c. Playing an audible sound on alarm initiation or return to normal.
      d. Sending an email or alphanumeric pager to anyone listed in a workstation’s email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system’s mail application interface (MAPI). No special software interfaces shall be required and no email client software must be running in order for email to be distributed.
      e. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
      f. It shall be possible to re-route an alarm if a user-defined response time has been exceeded. For example, if a critical alarm has an acknowledgment time of 5 minutes and that acknowledgement does not occur, the alarm can be re-routed to a secondary receiver.
g. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.

h. The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.

i. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

j. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

k. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.

l. An operator shall have the capability to assign an alarm to another user of the system. Such assignments shall be tracked to insure alarm response.

J. Report Generation:
1. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.

2. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.

3. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.

4. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.

5. Additional reports or sets of reports shall be downloadable, transferrable, and importable.

6. All reports shall be able to be set up to automatically run or be generated on demand.

7. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.

8. Reports can be of any length and contain any point attributes from any controller on the network.

9. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.

10. It shall be possible to run other executable programs whenever a report is initiated.

11. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

12. Minimum supplied reports shall include:
   a. Points in each controller.
b. Points in alarm.
c. Disabled points.
d. Overridden points.
e. Operator activity report.
f. Alarm history log.
g. Program listing by controller with status.
h. Network status of each controller.
i. Activities Per Server Report.
j. Activities Per User Report.
k. Alarm Amount by Category Report.
l. Alarm Amount by Type Report.
m. Alarms Per Sever Report.
o. Most Active Alarm Report.
q. Top Activities Report.
r. Top Alarms Report.
s. Top System Errors Report.
u. User Logins Report.
v. Users and Groups Reports.

13. Minimum Energy Reports shall include:
   a. Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
   c. Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.

14. Reports Server Software Requirements:
   b. Microsoft SQL Server 2008 with Advanced Services.
   c. Microsoft Net 3.5 SP1.

K. Scheduling:
1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3. Schedules shall be programmable for a minimum of one year in advance.
4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.

L. Programmer's Environment:
   1. Programming in the NSC shall be either in graphical block format or line-programming format or both.
   2. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
   3. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software off-line (if desired) for custom program development, and write global control programs.
   4. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
   5. It shall be possible to view graphical programming live and real-time from the Workstation.

M. Saving/Reloading:
   1. The workstation software shall have an application to save and restore NSC and field controller memory files.
   2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

N. Audit Trail:
   1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
   2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
   3. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.

O. Fault Tolerant Enterprise Server Operation (Top level NSC): A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

P. Web-based Operator Software:
   1. General: Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
2. Graphic Displays:
   a. The browser-based interface must share the same graphical
displays as the Administration and Programming Workstations,
presenting dynamic data on site layouts, floor plans, and
equipment graphics. The browser's graphics shall support
commands to change setpoints, enable/disable equipment and
start/stop equipment.
   b. Through the browser interface, operators must be able to navigate
through the entire system, and change the value or status of any
point in any controller. Changes are effective immediately to the
controller, with a record of the change stored in the system
database.

3. Alarm Management:
   a. Systems requiring additional client software to be installed on a
PC for viewing the webstation from that PC will not be considered.
   b. Through the browser interface, a live alarm viewer identical to the
alarm viewer on the Administration and Programming workstation
shall be presented, if the user's password allows it. Users must
be able to receive alarms, silence alarms, and acknowledge
alarms through a browser. If desired, specific operator text must
be able to be added to the alarm record before acknowledgement,
attachments shall be viewable, and alarm checklists shall be
available.

Q. Groups and Schedules:
   1. Through the browser interface, operators must be able to view pre-
defined groups of points, with their values updated automatically.
   2. Through the browser interface, operators must be able to change
schedules – change start and stop times, add new times to a schedule,
and modify calendars.

R. User Accounts and Audit Trail:
   1. The same user accounts shall be used for the browser interface and for
the operator workstations. Operators must not be forced to memorize
multiple passwords.
   2. All commands and user activity through the browser interface shall be
recorded in the system’s activity log, which can be later searched and
retrieved by user, date, or both.
   3. The intent of this specification is to provide a peer-to-peer networked,
stand-alone, distributed control system with the capability to integrate
both the ANSI/ASHRAE Standard 135-2004 BACnet® and LonWorks
technology communication protocols in one open, interoperable system.

2.3 NETWORK SERVER CONTROLLERS (NSCS)

A. Network Router Controllers shall combine both network routing functions, control
functions, and server functions into a single unit.

B. The BACnet NSC shall be classified as a “native” BACnet device, supporting the
BACnet Network Server Controller (B-BC) profile. Controllers that support a
lesser profile such as B-SA are not acceptable. NSCs shall be tested and
certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

D. They shall also be responsible for monitoring and controlling their own HVAC equipment such as a rooftop unit.

E. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

F. It shall be capable of executing application control programs to provide:
   1. Calendar functions.
   2. Scheduling.
   3. Trending.
   5. Time synchronization by means of an Internet site including automatic synchronization.
   6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data.

G. **Hardware Specifications:**
   1. **Memory:** The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
   2. Each NRC shall provide the following on-board hardware for communication:
      a. One (1) 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet.
      b. Two (2) RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable).
      c. One TP/FT port for communication to LonWorks devices.
      d. One Device USB port.
      e. Two host USB Ports.

H. **Modular Expandability:** The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

I. **Hardware Override Switches:** All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be
obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

J. Local Status Indicator Lamps: The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

K. Real Time Clock (RTC): Each NSC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.

L. Power Supply: The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.

M. Automatic Restart After Power Failure: Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

N. Battery Backup: The NSC shall include an on-board battery to back up the controller's RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.

O. Software Specifications:
   1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
   2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.
P. User Programming Language:
1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
2. Network Server Controllers that use a “canned” program method will not be accepted.

Q. Control Software:
1. The NSC shall have the ability to perform the following pre-tested control algorithms:
   a. Proportional, Integral plus Derivative Control (PID).
   b. Two Position Control.
   c. Digital Filter.
   d. Ratio Calculator.
   e. Equipment Cycling Protection.

R. Mathematical Functions: Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

S. NSCs shall have the ability to perform any or all of the following energy management routines:
1. Time of Day Scheduling.
2. Calendar Based Scheduling.
3. Holiday Scheduling.
4. Temporary Schedule Overrides.
5. Optimal Start.
6. Optimal Stop.
7. Night Setback Control.
8. Enthalpy Switchover (Economizer).
9. Peak Demand Limiting.
11. CFM Tracking.
15. Chilled Water Reset.
17. Chiller Sequencing.
T. History Logging:
1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 values shall be stored in each of these types of logs. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
3. Every hardware input and output point shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
4. The presentation of logged data shall be built into the server capabilities of the NSC Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.

U. Alarm Management:
1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point.
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

V. Embedded Web Server: Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

2.4 LON FIELDBUS AND LON SDCUS (Coordinate requirements with existing Facility Management System)
A. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second and 100 megabits per second.

B. Field Bus:
1. The field busses shall be FTT-10A operating at 78 kilobits per second.
2. The wiring of components shall use a bus or daisy chain concept with no tees, stubs or free topology.
3. The wiring type and length limitations shall conform to Echelon’s Junction Box and Wiring Guideline for Twisted Pair LonWorks Networks.
4. Each field bus shall have a termination device at both ends of each segment.

C. IP to Field Bus Router:
1. These devices shall perform layer 3 routing of ANSI/EIA 709.1B packets onto the IP network.
2. These devices shall be configurable locally without the use of the IP network (local cross over cable connection is acceptable) and configurable via the IP network.
3. These devices shall be configurable as routers such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

D. Network Server Controller:
1. These devices shall perform layer 3 routing of ANSI/EIA 709.1B packets onto the IP network.
2. These devices shall be configurable locally without the use of the IP network (local cross over cable connection is acceptable) and configurable via the IP network.
3. These devices shall be configurable as routers such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.
4. These devices shall provide the following support for the field bus devices that are connected below the Network Server Controller.
   a. Time schedules.
   b. Trend logging.
   c. Alarm message generation and handling.
5. These devices may provide supervisory logic support for the field bus devices that are connected below the Network Server Controller.
6. These devices may have physical inputs and outputs and provide process control for systems using these inputs and outputs.
7. If a Network Server Controller has physical inputs and outputs, it shall also comply with all of the requirements for programmable process controllers.

E. Physical Layer Repeaters (PLR):
1. PLRs are required to connect two segments to create a channel.
2. The design of the PLRs shall conform to LONMark standards.
3. LON to LON routers configured as repeaters may be used as a PLR.
4. Physical layer repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.
F. Standalone Digital Control Units (SDCUs):

1. General Requirements:
   a. Devices shall incorporate a service pin which, when pressed, will cause the device to broadcast its 48 bit node ID and its program ID over the network. The service pin shall be distinguishable and accessible.
   b. Devices shall have a light indicating that they are powered.
   c. Devices shall incorporate a TP/FT-10A transceiver in accordance with ANSI/EIA 709.3 and connections for TP/FT control network wiring.
   d. Devices shall be locally powered. Link powered devices are not acceptable.
   e. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings.

2. Programmable Process Controllers (PPC). The key characteristics of a PPC are:
   a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices and binary output devices. The number and type of input and output devices supported will vary by model.
   b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O may be by additional circuit boards that physically connect to the basic controller or by a standalone device that communicates with the basic controller via the FTT-10A field bus.
   c. The application to be executed by a PPC is created by an application engineer using the vendor's application programming tool.
   d. PPCs may or may not support embedded time schedules. When time schedules are not embedded in a PPC, an occupancy command shall be an input network variable when time based control is required by the sequence of control. Systems that use a Network Server Controller shall provide time schedule support in the Network Server Controller and the PPCs are not required to support for time schedules. Systems that use LON to IP routers require that PPCs support embedded time schedules.
   e. PPCs may or may not support trend data storage with periodic upload to the data server. When trend data storage is not supported, the variables to be trended shall be broadcast over the field bus to another device that does support embedded trend data storage. Systems that use a Network Server Controller shall provide trend logging support in the Network Server Controller and the PPCs are not required to support trend logging. Systems that use LON to IP routers require that PPCs support embedded trend logging.
   f. PPCs (shall, may or may not) (Choose one) support the initiation of an alarm message to the system server. When alarm message initiation is not supported, binary alarm indication variables shall be broadcast over the field bus to another device that does
support the initiation of alarm messages to the system server. Systems that use a Network Server Controller shall provide alarm message initiation support in the Network Server Controller and the PPCs are not required to support alarm message initiation. Systems that use LON to IP routers require that PPCs support alarm messaging initiation.

3. Analog Input Circuits:
   a. The electrical signals from analog sensors shall be processed by an analog to digital (A/D) converter chip. The output of the A/D chip shall then be processed mathematically to produce data within the controller that has the required engineering units.
   b. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
   c. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
   d. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
   e. For non-linear sensors such as thermistors and flow sensors the PPC shall provide software support for the linearization of the input signal.

4. Binary Input Circuits:
   a. Dry contact sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.

5. Pulse Input Circuits:
   a. Pulse input sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
   c. The pulse input circuit shall be able to process up to 50 pulses per second.

6. True Analog Output Circuits:
   a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
   b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.

7. Pulse Width Modulation Outputs with PWM transducers.
8. The controller shall be able to generate incremental pulses as small as 0.1 seconds.
9. Binary Output Circuits:
   a. Single pole single throw or single pole double throw relays with 
support for up to 230 VAC and a maximum current of 2 amps.
   b. Voltage sourcing or externally powered triacs with support for up 
to 30 VAC and 0.8 amps.

10. Program Execution:
   a. Process control loops shall operate in parallel and not in sequence 
      unless specifically required to operate in sequence by the 
      sequence of control.
   b. The sample rate for a process control loop shall be adjustable and 
      shall support a minimum sample rate of 1 second.
   c. The sample rate for process variables shall be adjustable and 
      shall support a minimum sample rate of 1 second.
   d. The sample rate for algorithm updates shall be adjustable and 
      shall support a minimum sample rate of 1 second.
   e. The application shall have the ability to determine if a power cycle 
      to the controller has occurred, and the application programmer 
      shall be able to use the indication of a power cycle to modify the 
      sequence of control immediately following a power cycle.

11. Local Interface: The controller shall support the connection of a portable 
    interface device such as a laptop computer or vendor unique hand-held 
    device. The ability to execute any tasks other than viewing data shall be 
    password protected. Via this local interface, an operator shall be able to:
   a. Adjust application parameters.
   b. Edit time schedule parameters if time schedules are embedded in 
      the controller.
   c. Execute manual control of input and output points.
   d. View dynamic data.
   e. View alarm messages if alarm messaging is embedded in the 
      controller.

12. Each PPC shall have a network interface port that allows for an external 
    device to connect to the FTT-10A network by plugging into the port. This 
    port shall be built into the controller.

G. Supervisory Logic Controller (SLC):
1. The key characteristics of an SLC are:
   a. The application to be executed by as SLC is created by an 
      application engineer using the vendor's application programming 
      tool.
   b. SLCs (shall, may or may not) (Choose one) support embedded 
      time schedules. When time schedules are not embedded in a 
      SLC, an occupancy command shall be an input network variable 
      when time based control is required by the sequence of control. 
      Systems that use a Network Server Controller shall provide time 
      schedule support in the Network Server Controller and the SLCs 
      do not have to support for time schedules. Systems that use a 
      LON to IP router will provide time schedule support in the SLCs.
   c. SLCs (shall, may or may not) (Choose one) support trend data 
      storage with periodic upload to the data server. When trend data 
      storage is not supported, the variables to be trended shall be 
      broadcast over the field bus to another device that does support
embedded trend data storage. Systems that use a Network Server Controller shall provide trend logging support in the Network Server Controller and the SLCs are not required to support trend logging. Systems that use LON to IP routers require that SLCs support embedded trend logging.

d. SLCs (shall, may or may not) (Choose one) support the initiation of an alarm message to the system server. When alarm message initiation is not supported, binary alarm indication variables shall be broadcast over the field bus to another device that does support the initiation of alarm messages to the system server. Systems that use a Network Server Controller shall provide alarm message initiation support in the Network Server Controller and the SLCs are not required to support alarm message initiation. Systems that use LON to IP routers require that SLCs support alarm messaging initiation.

2. Program Execution:
   a. Control algorithms shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
   b. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
   c. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of control immediately following a power cycle.

3. Local Interface:
   a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
      1) Adjust application parameters.
      2) Edit time schedule parameters if time schedules are embedded in the controller.
      3) Execute manual control of input and output network variables.
      4) View dynamic data.
      5) View alarm messages if alarm messaging is embedded in the controller.

4. Each SLC shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.

5. Programmable Process Controllers (PPCs) with un-used I/O may be used as Supervisory Logic Controllers provided they meet all other requirements.

6. Supervisory logic controllers shall have support a minimum of 200 input network variables and 70 output network variables.
   a. The SNVT for each of the 200 input network variables shall be selectable.
   b. The SNVT for each of the 70 output network variables shall be selectable.
7. For the input and output network variables there shall not be any limitations as to the SNVT selected. (Example: SNVT_temp_p can only be used on 10 input network variables.)

H. Application Specific Devices (ASD):
1. ASD shall have fixed function configurable applications.
   a. If the application can be altered by the vendor’s application programming tool, the device is a programmable controller and not an application specific device.
   b. All input and output network variables shall be formatted with SNVTs.
   c. All input configuration parameters shall be formatted with SNVTs or SCPTs. If UNVTs or UCPTs are used, the device resource files that allow these custom parameters to be read shall be provided to the owner.
   d. The network interface shall conform to the LonMark profile for the application provided by the ASD.
   e. Each ASD shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.

2.5 BACNET FIELDBUS AND BACNET SDCUS (Coordinate requirements with existing Facility Management System)

A. Networking:
   1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
   2. IP to Field Bus Routing Devices:
      a. A Network Server Controller shall be used to provide this functionality.
      b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
      c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

B. Field Bus Wiring and Termination:
   1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
   2. Each field bus shall have a termination resistor at both ends of each segment.
   3. The field bus shall support the use of wireless communications.

C. Repeaters:
   1. Repeaters are required to connect two segments.
   2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

D. Field Bus Devices:
   1. General Requirements:
      a. Devices shall have a light indicating that they are powered.
b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.

c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

E. Network Server Controllers (NSCs):
1. If NSCs have embedded I/O, all of the requirements for I/O that are described under Advance Application Controllers shall apply.
2. Shall support the export of data to NSCs from other vendors that support the data sharing, read property service.
3. Shall support the export of data using Change of Value (COV) initiation to NSCs from other vendors that support the subscription to data using the COV concept.
4. Shall support the export of data to any BACnet OWS that supports the data sharing, read property service.
5. Shall support the export of data using Change of Value (COV) initiation to any BACnet OWS that supports the subscription to data using the COV concept.
6. Shall provide trend log support for all of the devices on the field bus. They shall provide sufficient memory to store up to 300 samples for each variable required to be trended by the sequence of control.
7. Shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
8. Shall provide time schedule support for all of the devices on the field bus.
9. Shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
10. Shall provide alarm message initiation for all alarms conditions from any of the field bus devices.
11. Shall deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the notification.
12. Shall support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.
13. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
14. Shall support the receipt and response to Time Synchronization commands from any device that supports the BACnet service for initiating time synchronization commands.
15. Shall support the “Who is?” and “I am.” BACnet service.
16. Shall support the “Who has?” and “I have.” BACnet service.
17. Shall support Backup and Restore commands from any BACnet OWS that supports the initiation of Backup and Restore commands.
18. Shall be BTL certified.
F. Advance Application Controllers (B-AAC):
   1. The key characteristics of a B-AAC are:
      a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
      b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
      c. The application to be executed by a B-AAC is created by an application engineer using the vendor’s application programming tool.
      d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
      e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
      f. If local alarm message initiation is embedded, the B-AAC shall:
         1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the alarm message.
         2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.
      g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
      h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
      i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
      j. Shall support the “Who is” and “I am.” BACnet services.
      k. Shall support the “Who has” and “I have.” BACnet services.
   2. Analog Input Circuits:
      a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
      b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
      c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value
and a high range value are adjusted to match values determined by a calibration instrument).

d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.

3. Binary Input Circuits:
   a. Dry contact sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.

4. Pulse Input Circuits:
   a. Pulse input sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
   c. The pulse input circuit shall be able to process up to 20 pulses per second.

5. True Analog Output Circuits:
   a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
   b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.

6. Binary Output Circuits:
   a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
   b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

7. Program Execution:
   a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
   b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
   c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
   d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
   e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

8. Local Interface: The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
   a. Adjust application parameters.
   b. Execute manual control of input and output points.
   1) View dynamic data.
G. Application Specific Devices:
1. Application specific devices shall have fixed function configurable applications.
2. If the application can be altered by the vendor’s application programmable tool, the device is an advanced application controller and not an application specific device.
3. Application specific devices shall be BTL certified.

PART 3 PRODUCTS

3.1 MATERIALS

All products supplied as part of this contract shall be currently manufactured and cataloged products for use in new installations. Products under development or test shall not be used. Spare parts shall be available for at least five years after completion of this contract.

3.2 WIRING TYPES AND SPECIFICATIONS

A. Control wiring for binary sensors shall be 18 AWG copper and shall be rated for 300-volt service. There shall be one (1) extra conductor pulled that can be used for future expansion, and the drain/shield shall not be used as a conductor.

B. Wiring for digital outputs shall be 18 AWG or thicker stranded copper and shall be rated for 600-volt service.

C. Control wiring for analog signals shall be 18 AWG, copper, single or multiple strand, twisted (minimum 50 mm lay of twist), 100percent shielded pairs and shall have 300 volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. There shall be 1 extra conductor pulled that can be used for future expansion, and the drain/shield shall not be used as a conductor.

D. Network cable for the LON field bus shall meet the LONMark wiring guidelines for TP/FT-10 segments with installed devices having FTT-10A free topology transceivers. This network cable can be found at the below cable suppliers for Level IV LON.
   1. Level IV network cable is - 22 AWG 7/30 Bare Copper – 2 conductor stranded, with or without a 7/32 drain wire, (17 pF/ft), and impedance of 100 ohm (1-20MHz) nominal UL TYPE SUBJECT 444, CMP.

E. Network cable for the BACnet field bus shall meet the BACnet wiring guidelines for RS485 segments with installed devices having Level 1 transceivers or communication ports for RS485. This network cable can be found at the below cable suppliers for Low Cap RS485 cable.

F. Network Cable is - 24 AWG 7/26 Bare Copper – 2 conductor stranded, 7/32 drain wire, (12.5 pF/ft) @ 1 KHz nominal UL TYPE CMP/CL3P 24 AWG.

G. IP Network cable shall meet or exceed all requirements of Category 5 cable as specified in ANSI/TIA/EAI 568-A.
H. All cabling will be UL listed and labeled for plenum use.

3.3 INTERLOCKING AND CONTROL WIRING

A. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state, and local electrical codes. Insulated wire should use copper conductors and shall be UL Listed for 200°F minimum service.

B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.

C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the Owner’s Representative prior to rough-in.

D. Provide auxiliary pilot duty relays on motor starters as required for control function.

E. Provide power for all control components from nearest electrical control panel or as indicated on the Electrical Drawings—coordinate with Electrical Contractor.

F. All control wiring in the mechanical, electrical, telephone rooms, in vertical risers between floors or exposed to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum rated cable (without conduit). All conduit on roof shall be EMT with rain tight fittings. Line voltage control wiring shall be run in EMT.

G. Route control wiring to Central Plant in conduit routed from main building to the Central Plant building provided by the Electrical Contractor.

3.4 CABLE SUPPLIERS

A. The following is a list of identified suppliers for the Schneider Electric Americas cabling:

   Primary Source: Connect Air
   Allan Pick
   www.connect-air.com
   Phone: 800-247-1978
   Fax: 253-813-5699

   Secondary Source: Communications Supply Corporation
   Betty McMurrough
   www.gocsc.com
   Phone: 505-344-3400
   Fax: 505-345-3862
END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Direct Digital Controls System.
B. Packaged Rooftop Units.
C. Variable Air Volume Packaged Rooftop Units.
D. Single Duct VAV Terminal Units.
E. Series Fan Powered VAV Terminal Units.
F. Parallel Fan Powered VAV Terminal Units.
G. Exhaust Fans.
H. District Workstation Graphics.

1.2 SYSTEM DESCRIPTION

A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

B. Provide all operations described in sequence of operations and as required by Drawings.

1.3 DIRECT DIGITAL CONTROLS SYSTEM

A. HVAC System:
   1. The Direct Digital Controls System (DDC) shall energize and de-energize each component of HVAC system individually, including Rooftop Units, Variable Air Volume Terminal Units and all other equipment requiring control in this Specification Section. Equipment shall operate on a predetermined schedule. Refer to the Equipment Schedule for Exhaust Fan control requirements.
   2. Occupied Mode: The occupied mode shall be on a totally programmable time schedule. HVAC system shall operate to maintain space thermal conditions and ventilation rates.
   3. Unoccupied Mode: The unoccupied mode shall be on totally programmable time schedule. HVAC system shall operate to maintain space thermal conditions and ventilation rates for purposes of set-back environment.
4. Combined Modes: The HVAC system shall be capable of assigning occupied mode status to any portion of the facility while simultaneously assigning unoccupied mode status to other portions in order to accommodate special events. As example, classrooms may be unoccupied in the evening while the Cafeterium is occupied.

5. Coordinate occupied/unoccupied/combined mode time schedules with School District.

1.4 TEST AND CALIBRATION

A. After completion of installation, all controls shall be tested and calibrated to operate as required in this Specification.

B. Upon request by the Architect's Representative, demonstration of proper control system operation shall be provided prior to final job acceptance.

1.5 GENERAL REQUIREMENTS

A. Enclosures: All outdoor mounted DDC Unit Controllers shall be installed in a NEMA 4 metal enclosure. Indoors, the TC or PCU shall be mounted in a NEMA-1 metal panel. In ceilings, the TC may be mounted without a separate enclosure with its standard TC cover.

B. Space override buttons will be provided in the following zones: Administrative Office, and Library. Override buttons will be located at the space temperature sensors. Override buttons will provide a maximum of two (2) hours (adj.) of operation for that zone and the system shall return to unoccupied mode after the override time expires. Operation of the override button will enable the occupied mode cooling, heating systems, and air distribution systems for that zone.

C. All space temperature sensors shall have a temperature setpoint adjustment that can be limited in software to plus or minus 2 Deg. F. adjustment range from set point. The set point range shall be adjustable.

D. Space Thermostat and Sensor Covers: Provide lockable Lexan covers over space thermostats and temperature sensors located in the Library.

E. Duct smoke detectors shall be provided, installed, and wired for fan shutdown by Division 16. A duct smoke detector is to be mounted at the supply and return air of each rooftop unit over 2,000 CFM, which will stop the unit upon a detection of smoke.

F. Power: Division 16 shall provide 110 VAC at each DDC controller location and each VAV box. Controls Contractor shall provide necessary step-down transformers for 24 VAC.

G. Dampers: Coordinate damper actuator compatibility requirements with the rooftop unit manufacturer. The outside air dampers will be closed when the
rooftop units are de-energized, in the unoccupied mode or in the pre-cooling mode and pre-heating cycle.

H. Air Balance: The Test and Balance Contractor shall measure and verify the correct settings required for 50% of scheduled OA and 100% scheduled OA by setting OA and RA dampers through software.

I. Actuators: All valve and damper actuators shall be electronic type. Only OA damper actuators need to be spring return.

J. DDC Outputs: Separate DDC outputs will be provided for each valve, damper actuator.

K. DDC Control: All sensors and actuators described below shall be controlled / monitored by the direct digital control system. Thermostats and humidistats wired to actuators will not be allowed.

L. Occupied Period Set Points: 75 Deg. F. cooling, 70 Deg. F. heating, humidity shall be controlled to 60% maximum

M. After Hours and Unoccupied Periods: Provide night building low limits of 60 Deg. F. and night high limits of 85 Deg. F. Dewpoint shall be controlled at 62 degrees maximum. Humidity shall be controlled to 60% maximum.

N. Coordinate occupied/unoccupied periods with Owner.

O. Economizer Control: The BMS shall override the economizer controller on the rooftop unit to provide free cooling. If poor outdoor air conditions exist, the BMS shall lockout all economizers. On constant volume units the BMS shall also set the minimum economizer position to maintain a minimum outdoor air flow (cfm). On VAV units, as the supply fan modulates down, the minimum economizer position shall also be reset to compensate for the reduction in total airflow.

1.6 CONSTANT VOLUME PACKAGED ROOFTOP UNIT (RTU-1 and RTU-3)

A. Building Automation System Interface: The DDC Controls System (DDC) will send the controller Occupied, Unoccupied, Optimal Start, Night Heat / Cool, and Timed Override commands. If communication is lost with the DDC, the controller will operate using its local schedule and setpoints.

B. Unoccupied Mode: In the unoccupied mode the rooftop unit (RTU) will cycle as required to maintain the adjustable (adj) unoccupied space heating, cooling and humidity setpoints. When the associated zone temperature rises above or falls below the unoccupied setpoint, the RTU will be enabled. Once enabled, the supply fan, heat, and DX cooling will cycle as required to maintain the unoccupied zone temperature setpoint. The outside air damper will remain closed, and the return air damper will remain open during unoccupied mode.
C. Morning Warm-Up Mode: On a transition from the unoccupied mode to occupied mode, if the zone temperature is 3°F below the occupied setpoint a morning warm-up routine mode will be activated. When morning warm-up is initiated the RTU will enable the unit’s heat and supply fan. The outside air damper will remain closed. When the zone temperature reaches setpoint (adj), the RTU will transition to the occupied mode.

D. Cool-Down Mode: On a transition from the unoccupied mode to occupied mode, if the zone temperature is 3°F above the occupied setpoint a morning cool-down mode will be activated. When morning cool-down is initiated the RTU will enable the fan and DX cooling or economizer. The outside air damper will remain closed. When the zone temperature reaches setpoint (adj), the RTU will transition to the occupied mode.

E. Occupied Mode: The RTU will enable cooling, heating or the hot gas reheat dehumidification cycle to maintain zone temperature and humidity setpoints (adj). The outdoor air damper will open to the minimum setpoint.

F. Cooling Mode: The controller uses zone temperature and zone temperature setpoint to determine when to initiate requests for cooling. When the zone temperature rises above the setpoint, the controller will enable stage-1 of cooling. The controller will call for the supply fan to turn on. The first compressor will energize after its minimum 3-minute off time has expired. If additional cooling capacity is required the second stage of cooling will be enabled. Once the zone temperature falls below the setpoint the compressors and fan will be deactivated. The supply fan will remain on for a period of 60 seconds after the compressor output is de-energized for free cooling.

G. Heating Mode: The controller uses zone temperature and zone temperature setpoint to determine when to initiate requests for heat. When the zone temperature drops below the setpoint, the controller will enable heat. The controller will call for the supply fan to turn on. The unit controller will modulate heating capacity to maintain the zone temperature setpoint. Once the zone temperature rises above the setpoint the heating and the fan will be disabled. On gas heat units the supply fan will remain on for a period of 90 seconds after heat is deactivated for free heating and heat exchanger cool down.

H. Fan Operation: The supply fan will be enabled while in the occupied mode and cycled on during the unoccupied mode. A differential pressure switch will monitor the differential pressure across the fan. If the switch does not open within 40 seconds after a request for fan operation a fan failure alarm will be annunciated, the unit will stop, requiring a manual reset.

I. Timed Override (TOV): Area controls monitor the status of the “ON” and “CANCEL” buttons of the zone temperature sensors associated with the area. When a timed override request from a zone temperature sensor, is sensed, the area will change from its current state to occupied.
A. Sequence of Operation: Provide a “Microprocessor Interface Panel”. All setpoint adjustments shall be capable of adjustment through the DDC system.

B. Variable Frequency Drive Control (Discharge duct static pressure setpoint optimization):
1. The building automation system (BAS) shall continuously monitor the damper position of all VAV terminal units. The discharge duct static pressure shall be sensed directly at the discharge of each rooftop air handler. The sensor must be mounted in a non-turbulent location.
2. 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.
3. 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.
4. 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.
5. The BAS shall have the capability to allow the operator to exclude “problem” zones that should not be considered when determining the optimized setpoint.
6. The BAS shall also read the status of the supply air static pressure sensor and display the active duct static pressure reading on the status screen.
7. The BAS 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.
8. During the commissioning process, the controls contractor shall demonstrate the performance of fan pressure optimization.
9. Bypass control shall be provided to allow full nominal airflow in the event of drive failure.

C. Supply Air Static Pressure Limit: Energizing of the supply fan and VAV boxes shall be coordinated during unit startup and transition to/from Occupied/Unoccupied modes to prevent over-pressurization of the supply air ductwork. Provide a duct mounted static pressure sensor. If the supply air pressure exceeds the user-defined supply air static pressure limit that was
set at the Microprocessor Interface Panel, the supply fan/VFD shall shut down and the inlet guide vanes shall close. The unit shall allow three restart times. If the over-pressurization condition occurs on the third time, the unit shall shut down and a manual reset diagnostic set and displayed at the Microprocessor Interface Panel.

D. Cooling: During Occupied cooling mode of operation, the mechanical cooling shall be used to control the supply air temperature. The supply air temperature setpoint and deadband are user-defined at the Microprocessor Interface Panel. Mechanical cooling shall be staged on to maintain supply air temperature setpoint. Minimum On/Off timing of the mechanical cooling shall prevent rapid cycling. At outdoor air conditions above the enthalpy control setting, mechanical cooling is used and the fresh air dampers remain at minimum position. Outdoor air dampers may be set manually for a maximum of 25 percent outdoor air, if rooftop is equipped with 0 to 25 percent manual fresh air damper.

E. Supply Air Setpoint Reset: Supply air reset shall be used to adjust the supply air temperature setpoint on the basis of a zone temperature or on outdoor air temperature. Supply air reset adjustment shall be available from the Microprocessor Interface Panel for supply air cooling control.
1. Reset Based On Outdoor Air Temperature:
   a. Outdoor air cooling reset shall be used when the outside air temperature is low and the building cooling load is low. The supply air setpoint shall be adjustable. For outdoor air cooling reset, provide three (3) user defined parameters that are adjustable through the Microprocessor Interface Panel.
      1) Beginning Reset Temperature.
      2) Ending Reset Temperature.
      3) Maximum Amount of Temperature Reset.
   b. Reset Based On Zone Temperature: Zone reset shall be applied to the zone(s) in a building that tend to overcool or overheat. The supply air temperature setpoint shall be adjusted based on the temperature of the critical zone(s). The user-defined parameters are the same as for outdoor air reset.

F. Zone Temperature Control: Unoccupied Zone Cooling: During Unoccupied mode, the unit is operated as a CV unit. Inlet guide vanes and VAV boxes are driven full open. The unit controls zone temperature within the unoccupied zone cooling deadbands. The outside air damper shall remain closed.

G. Space Pressure Control: A pressure transducer is used to measure and report direct space (building) static pressure. The user-defined control parameters used in this control scheme are space static pressure setpoint and deadband. As the economizer opens, the building pressure rises and enables the dampers. The barometric damper will be utilized for building static pressure relief.
H. Ventilation Override Module (VOM): The user shall have the ability to customize up to five (5) different override sequences for purposes of ventilation override control. If more than one VOM sequence is being requested, the sequence with the highest priority shall be initiated first. Sequence hierarchy is the first sequence “A” with sequence “D” last. A ventilation override mode shall be initiated by closing any of the five (5) corresponding binary inputs on the VOM module. A binary output is provided on the VOM module to provide remote indication of an active VOM mode. All compressors, condenser fans and the humidification output are de-energized for any VOM sequence. The factory default definitions for each mode are as follows:

1. UNIT OFF Sequence “A”. When complete system shutdown is required the following sequence may be used:
   b. Supply Fan IGV / Supply Fan VFD - Closed/Min (if so equipped).
   c. OA Dampers – Closed; Return Damper – Open.
   d. Occupied/Unoccupied/VAV Box Output – De-energized.
   e. VOM Relay – Energized.
   f. OA Bypass Dampers - Open (if so equipped).

2. PRESSURIZE Sequence “B”. The supply fan shall be energized with VFD at 100% speed.
   b. Supply Fan IGV / Supply Fan VFD - Max (if so equipped).
   c. OA Dampers – Open; Return Damper – Closed.
   d. Occupied/Unoccupied/VAV Box Output – Energized.
   e. VOM Relay – Energized.
   f. OA Bypass Dampers – Open (if so equipped).

3. PURGE Sequence “C”: This sequence shall be used for purging the air out of a building before coming out of unoccupied mode of operation on VAV units or for purging smoke or stale air subsequent to a fire.
   b. Supply Fan IGV/ Supply Fan VFD – Max (if so equipped).
   c. OA Dampers – Open; Return Damper – Closed.
   d. Occupied/Unoccupied/VAV Box Output – Energized.
   e. VOM Relay – Energized.
   f. OA Bypass Dampers – Open (if so equipped).

4. PURGE With Duct Pressure Control Sequence “D”: This sequence shall be used when supply air control is required for smoke control.
   b. Supply Fan IGV / Supply Fan VFD – (If so equipped) Controlled by Supply Air Pressure Control function; Supply Air Pressure High Limit disabled.
   c. OA Dampers – Open; Return Damper – Closed.
   d. Occupied/Unoccupied/VAV Box Output – Energized.
   e. VOM Relay – Energized.
   f. OA Bypass Dampers – Open (if so equipped).

5. Emergency Override: When a communication module is installed, the user shall have the ability to initiate from a 3rd Party BAS one of five
(5) predefined, not available to configure, Emergency Override sequences. All compressors, condenser fans and the humidification output are de-energized for any Emergency Override sequence. Each Emergency Override sequence commands the unit operation as follows:

a. EMERG_PRESSURIZE:
   1) Supply Fan – On.
   2) Supply Fan IGV / Supply Fan VFD Open/Max (if so equipped).
   3) OA Dampers – Open; Return Damper – Closed.
   4) Occupied/Unoccupied/VAV Box Output – Energized.
   5) VOM Relay – Energized (if so equipped).

b. EMERG_DEPRESSURIZE:
   1) Supply Fan – Off.
   2) Supply Fan IGV / Supply Fan VFD - Closed/Min (if so equipped).
   3) OA Dampers – Closed; Return Damper – Open.
   4) Occupied/Unoccupied/VAV Box Output – Energized.
   5) VOM Relay – Energized (if so equipped).

c. EMERG_PURGE:
   1) Supply Fan – On.
   2) Supply Fan IGV / Supply Fan VFD - Open/Max (if so equipped).
   3) OA Dampers – Open; Return Damper – Closed.
   4) Occupied/Unoccupied/VAV Box Output – Energized.
   5) VOM Relay – Energized (if so equipped).

d. EMERG_SHUTDOWN:
   1) Supply Fan – Off.
   2) Supply Fan IGV / Supply Fan VFD – Closed/Min (if so equipped).
   3) OA Dampers – Closed; Return Damper – Open.
   4) Occupied/Unoccupied/VAV Box Output – Energized.
   5) VOM Relay – Energized (if so equipped).

e. EMERG_FIRE - Input from fire pull box/system:
   1) Supply Fan – Off.
   2) Supply Fan IGV / Supply Fan VFD – Closed/Min (if so equipped).
   3) OA Dampers – Closed; Return Damper – Open.
   4) Occupied/Unoccupied/VAV Box Output – Energized.
   5) VOM Relay - Energized (if so equipped).

I. Microprocessor Interface Panel: The Microprocessor Interface Panel shall provide a liquid crystal display and a keypad for monitoring, setting, editing and controlling. The Microprocessor Interface Panel shall be mounted in the unit’s main control panel and shall be easily accessible.

1. Microprocessor Interface Panel Main Menu:
   a. STATUS – Shall be used to monitor all temperatures, pressures, humidity, setpoints, input, and output status.
b. CUSTOM KEY – Shall allow the user to customize a status report consisting of up to four (4) screens of the data available in the main Status menu.

c. SET POINTS – Shall be used to edit all factory preset Default setpoints.

d. DIAGNOSTICS – Shall be used to review active and historical lists of diagnostic conditions. A minimum of 49 different diagnostics must be read at the Microprocessor Interface Panel. The last 20 diagnostics can be held in an active history buffer log.

e. SETUP – Shall be used to Control parameters, sensor selections, setpoint source selections, output definitions, and numerous other points can be edited in this menu. All points shall have factory preset values.

f. CONFIGURATION – Shall be Preset with the proper configuration for the unit as it ships from the factory.

g. SERVICE: Shall be used to selectively control outputs (for compressors, fans, damper position, etc.) for servicing or troubleshooting the unit. This menu shall be accessible only at the unit-mounted Microprocessor Interface Panel.

J. Building Automation System Module (BAS): The Building Automation System Module (BAS 0-10 vdc) shall be used to provide control capabilities with the following minimum inputs and outputs:

1. Analog Inputs – Four (4) analog inputs, controlled via a field provided potentiometer or a 0-10 vdc signal, that can be configured to be any of the following:
   a. Unoccupied Zone Cooling Setpoint.
   b. Supply Air Cooling Setpoint.
   c. Space Static Pressure Setpoint.
   d. Supply Air Static Pressure Setpoint.
   e. Minimum Outside Air Flow Setpoint.
   f. Minimum Outside Air Position Setpoint.
   g. Occupied Humidification Setpoint.
   h. Unoccupied Humidification Setpoint.

2. Analog Outputs – Four (4) analog outputs that can be configured to be any of the following:
   a. Outdoor Air Temperature.
   b. Zone Temperature.
   c. Supply Air Temperature.
   d. Supply Air Pressure.
   e. Space Pressure.
   f. Space Relative Humidity.
   g. Outdoor Air Relative Humidity.
   h. Space CO2 Level.
   i. Compressor Staging (%).
   j. Outdoor Air Damper Position.
   k. Outdoor Airflow.
   l. Occupied Humidification Setpoint.
   m. Unoccupied Humidification Setpoint.
K. Binary Output: provide a single relay output that can be mapped to any/all of the available diagnostics.

L. Binary Input: The single binary input shall initiate or terminate the Demand Limit mode of operation, via a field supplied switch or contact closure.

M. Evaporator Coil Frost Protection: A temperature sensor on the evaporator shall be used to determine if the coil is getting close to a freezing condition. Mechanical cooling capacity shall be shed as necessary to prevent icing. The supply fans shall energize and will de-ice the coil. Timers shall prevent the compressors from rapid cycling.

N. Occupied/Unoccupied Switching: Three (3) ways to switch Occupied/Unoccupied:
   1. Night Setback Panel.
   2. Field-supplied contact closure (hardwired binary input to RTM).
   3. Third Party BAS with control module.

O. BAS System: A third party BAS shall control the Occupied/Unoccupied status of the rooftop.

P. Night Setback: Night setback (unoccupied mode) desired transition times shall be programmed through the DDC system and communicated to the rooftop. When the DDC system switches to night setback operation, the outdoor air dampers close and cooling can be enabled or disabled depending on set-up parameters. As the building load changes, the DDC system energizes the rooftop cooling function and the evaporator fan. The rooftop unit will cycle through the evening as cooling is required in the space. When the DDC system switches from night setback to occupied mode, all cooling functions begin normal operation. During night setback with a VAV cooling rooftop, adequate airflow must be maintained through the rooftop unit.

Q. Timed Override Activation: This function is active whenever the RTM is selected as the Zone Temperature Sensor source, which was set up at the Microprocessor Interface Panel. When this function is initiated by the push of an override button on the zone sensor, the unit will switch to the occupied mode. Automatic Cancellation of the Timed Override Mode occurs after two hours (adjustable) of operation.

R. Low Ambient Compressor Lockout: This function shall lock out the compressor if the outdoor air temperature is below the low ambient compressor lock out temperature set point. The factory setpoint is 50°F on standard units and 0°F on low ambient units. This setpoint is adjustable at the Microprocessor Interface Panel. Compressors will be locked out when outdoor air temperatures falls below that selected temperature and will be allowed to start again when the temperature rises 5°F above the setpoint.

S. Compressor Lead/Lag: Provide a user-selectable Compressor lead/lag feature through the Microprocessor Interface Panel. After each request for
compressor operation, the lead refrigeration circuit or compressor on units switches to balance run time among compressors. Provide this feature where available.

T. Emergency Stop Input: A binary input shall be provided on the Rooftop Module (RTM) for installation of field provided switch or contacts for immediate shutdown of all unit functions.

U. Low Charge Protection: Provide a low charge feature to measure the entering and leaving evaporator temperatures on each circuit to calculate a superheat value for each circuit. Microprocessor Interface panel shall display this value to assist the service technician with unit charging and diagnostics. The undercharged circuit will be locked out to protect the compressors.

V. BACnet® or LonTalk® Building Automation System: The BACnet or LonTalk Communication Interface for unit controller shall expand communications from the unit UCM network to a 3rd party building automation system, and shall allow external setpoint and configuration adjustment and monitoring of status and diagnostics. The interface controller shall utilize the MS/TP protocol as defined in ASHRAE standard 135-2004. This controller shall work in standalone mode when connected to a 3rd party building automation system. The interface controller shall be factory installed. Coordinate applicable requirements with the rooftop unit manufacturer prior to start of construction.

W. CO2 Demand Control Ventilation: CO2 Demand Control Ventilation shall provide ventilation for occupants. Demand control ventilation must be accomplished by minimizing the OA damper position or the OA flow setpoint below the Building Design Minimum, per ASHRAE Std 62.1-2004. If the measured CO2 level is below the CO2 Minimum Setpoint the OA damper shall close to the Minimum OA Damper Setpoint or until the Minimum OA flow Setpoint is met.

X. Unoccupied Mode Dehumidification Control: Provide a space humidity sensor and locate as shown on the Drawings. Should the humidity value exceed 60% RH, the system shall energize, terminal unit dampers shall open and the RTU fan shall modulate to 70% supply air cfm. Whenever the space humidity drops back below 55% RH, control of the RTU shall revert back to the space temperature control.

1.8 SINGLE DUCT VAV TERMINAL UNITS

A. These units consist of a primary damper and actuator, multi-point averaging velocity flow sensor, and electric heating coil.

B. When in occupied mode, the space temperature sensor shall modulate the primary air inlet damper open from its minimum primary air flow (25% or as shown on Drawings, adjustable) to its design CFM setting to maintain the space cooling setpoint. As the room temperature decreases, the primary air inlet damper shall be modulated toward the closed position until the minimum
airflow setpoint is reached. As room temperature continues to fall, the electric heater shall be modulated to maintain the space heating setpoint.

C. The space temperature sensors shall be provided with an after-hours override button to reset the space temperature setpoint to the occupied settings and energize the associated RTU equipment as required. The override time period shall be 60 minutes (adjustable) through the DDC controls system. Upon expiration of the override time period, the equipment operation shall revert to the unoccupied mode.

D. The space temperature shall through the DDC controller, energize the associated RTU fan and when the space temperature drops below the unoccupied setpoint of 60 Deg. F. (adjustable), the VAV terminal unit control shall modulate the electric heater to increase the space temperature to 10 Deg. F. above setpoint before de-energizing.

1.9 SERIES FAN POWERED VAV TERMINAL UNITS – PRESSURE INDEPENDENT WITH ELECTRIC REHEAT COIL

A. During occupied mode, fan runs continuously.

B. The DDC will modulate the VAV cooling/return air damper and reheat coil valve in sequence to achieve space temperature setpoint.

C. When space temperature exceeds the cooling setpoint, the variable air volume (VAV) damper will modulate open. As the temperature falls VAV damper modulates to minimum position. Minimum position will be based on the greater requirement of heating load, supply air temperature, or ventilation air requirements.

D. After damper reaches minimum position, the space temperature shall drift in a dead-band until reaching the heating control setpoint. As temperature continues to fall below setpoint, the reheat coil shall energize.

E. There are two modes of operation for setpoints, one for "occupied" mode (heating = 70°F, cooling = 75°F, adjustable) and one for "unoccupied" mode (heating = 55°F, cooling = 82°F, Adjustable). Refer to occupied/unoccupied mode control.

F. During unoccupied mode, fan will only operate when space temperature exceeds setpoint (either high or low). The damper will remain closed.

G. The space temperature sensors shall be provided with an after-hours override button to reset the space temperature setpoint to the occupied settings and energize the associated RTU equipment as required. The override time period shall be 60 minutes (adjustable) through the DDC controls system. Upon expiration of the override time period, the equipment operation shall revert to the unoccupied mode.

H. Programs:
   1. DDC – PID, Setpoint Control.
   2. Alarms and Messages:
      a. Zone Temp., high and low.

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b. Discharge Air Temp., high and low.
c. Day/Night Switch - Over.
d. Occupancy Override Switch.

I. Control Points:
2. VAV Damper – analog output.
3. Reheat Control – analog output.
5. Day/Night Switch – binary input.

J. The DDC VAV controller, damper motor, and transducer shall be supplied by the Controls Contractor and furnished to the terminal unit supplier. Provision of enclosure, transformer, and the cost to factory mount, calibrate and test the controls shall be included in the VAV terminal unit manufacturer’s price.

1.10 PARALLEL FAN POWERED VAV TERMINAL UNITS – PRESSURE INDEPENDENT WITH ELECTRIC REHEAT COIL

A. These units consist of:
1. A parallel fan.
2. A multi-point averaging velocity sensor.
3. A primary air damper and actuator.
4. An electric reheating coil.

B. During occupied mode, fan will operate when VAV damper closes to 30% of open or less.

C. The DDC will modulate the VAV cooling damper and reheat coil in sequence to achieve space temperature setpoint.

D. When space temperature exceeds the cooling setpoint, the variable air volume (VAV) damper will modulate open. As the temperature falls VAV damper modulates to minimum position. Minimum position will be based on the greater requirement of heating load, supply air temperature, or ventilation air requirements.

E. After damper reaches minimum position, the space temperature shall drift in a dead-band until reaching the heating control setpoint. As temperature continues to fall below setpoint, the reheat coil shall energize.

F. There are two (2) modes of operation for setpoints, one for "occupied" mode (heating = 70°F, cooling = 75°F, adjustable) and one for "unoccupied" mode (heating = 55°F, cooling = 82°F, Adjustable). Refer to occupied/unoccupied mode control.

G. During unoccupied mode, fan will only operate when space temperature exceeds setpoint (either high or low). The VAV damper remains closed.

H. Programs:
1. DDC – PID, Setpoint Control.
2. Alarms and Messages:
   a. Zone Temp., high and low.
b. Discharge Air Temp., high and low.

I. Control Points:
   2. VAV Damper – analog output.
   3. Reheat Coil Valve – analog output.

J. The DDC VAV controller, damper motor, and transducer shall be supplied by the Controls Contractor and furnished to the terminal unit supplier. Provision of enclosure, transformer, and the cost to factory mount, calibrate and test the controls shall be included in the VAV terminal unit manufacturer’s price.

1.11 EXHAUST FANS

Refer to the Equipment Schedule for control requirements. Provide minimum DDC control system start/stop control and current sensing relay (CSR) indicating ON/OFF status for all fans. If sensor fails to prove status, the DDC control system shall identify the unit and report an alarm. Coordinate kitchen hood supply and exhaust fans and control panel interlock with General Contractor and Kitchen Consultant prior to construction.

1.12 DISTRICT WORKSTATION GRAPHICS

A. All graphics shall match existing Southwest Texas Junior College graphics styles and layouts.

B. Equipment Graphics: Provide color graphic system displays of all system point and application data as described in the control sequences. All data shall be dynamic live data that automatically updates on a regular basis.

C. Provide simplified floor graphics for the areas covered in this specification by direct creation, or by use of AutoCAD files of the building design. The Architect shall provide AutoCAD files at no charge for this purpose.

END OF SECTION
SECTION 15990
TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Testing, adjusting, and balancing of air systems.
B. Measurement of final operating condition of HVAC systems.

1.2 SCOPE OF WORK

A. Mechanical Division shall secure the services of an independent Testing, Adjusting, and Balancing Agency to perform complete testing, adjusting, and balancing of the Heating, Ventilating and Air Conditioning system.

B. Responsibility of Mechanical Contractor:
1. Mechanical Contractor shall be responsible for complete system start-up prior to testing, adjusting and balancing and shall demonstrate operation of each item of mechanical equipment.
2. Motor amp draw shall be checked and adjusted to within 80% of rated amp draw during start-up procedures on all motors. Replace drive packages as necessary to achieve design conditions.
3. Set return air velocity to maximum 500 fpm at each air unit inlet during start-up procedures.
4. Attend pre-balancing conference with testing agency to demonstrate operation of system.
5. Install clean filters in all air units.
6. Verify that systems are complete and operable. Refer to Part 3, Paragraph 3.2 A.
7. Cooperate with Testing and Balancing Agency to provide all necessary data on the design and proper application of the system components and furnish all labor and material required to eliminate any deficiencies or malperformance. Resolve all operational deficiencies prior to submission of final TAB report.
8. Install all dampers, sheaves, and miscellaneous adjustment devices in a manner that will leave them accessible and readily adjustable. The TAB Agency may be consulted if there is a questionable arrangement of a control or adjustable device.
9. Coordinate duct leakage test requirements with TAB Contractor.

C. Responsibility of Testing, Adjusting, and Balancing Agency:
1. During construction, inspect the installation of ductwork, Facility Management System and all other components of the HVAC system. Inspection will cover that part of the work relating to proper arrangement and adequate provisions for the testing and balancing. The inspections shall be performed periodically as the work progresses with a minimum of two inspections as follows:
a. When 60% of ductwork is installed.
b. When 90% of ductwork is installed.

2. Submit brief written report of each inspection to Owner, Architect, Engineer, and Contractor.

3. Provide all instruments and equipment required to accomplish necessary testing, adjusting and balancing and as required by the Engineer to verify performance. All instruments shall be in accurate calibration and shall be calibrated in ranges that will be expected.

4. Field verify equipment nameplate electrical data. Do not derive data from submittal documents.

5. Upon completion of the installation and start-up of the mechanical equipment by the Mechanical Division, the Testing, Adjusting and Balancing Agency will test, adjust and balance the system components to obtain optimum conditions in each conditioned space in the facility. TAB Agency shall work with the Automatic Temperature Controls Contractor in commissioning the operation of all motorized/balancing duty control dampers. The TAB Agency is advised that deficiencies in HVAC construction are often encountered during final TAB services and Agency should include in bid proposal an amount it deems adequate to compensate for time in identifying the deficiencies to the Mechanical Contractor and awaiting their correction.

6. Fourteen calendar days, or earlier, prior to Owner's Final Inspection as requested by the General Contractor, the Testing and Balancing Agency shall prepare seven copies of the completed Testing and Balancing Report and submit one copy to Owner and six copies to the Architect/Engineer. The reports shall be certified accurate and complete by a principal Engineer of the Agency. Resolve all operational deficiencies prior to submission of final report.

7. Before any external insulation is applied to ductwork perform leakage test in accordance with ASHRAE 90.1-1999 standards regardless of pressure classification. Where leakage exceeds maximum allowable rate, provide remedial work as necessary for compliance. Coordinate requirements with HVAC Contractor. Duct leakage test to be limited to main medium pressure supply air ducts from RTVAV units.

1.3 REFERENCES

A. AABC - National Standards for Total System Balance.

B. ADC - Test Code for Grilles, Registers, and Diffusers.


1.4 SUBMITTALS

A. Submit under provisions of Section 15010 – Mechanical General Conditions: Submittals.

B. Submit name of adjusting and balancing agency for approval within fifteen (15) days after award of Contract.

C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

D. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

E. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

F. Provide reports in 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.

G. Include detailed procedures, agenda, sample report forms prior to commencing system balance.

H. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, forms prepared following ASHRAE 111 or NEBB forms.

1.5 PROJECT RECORD DOCUMENTS

Submit under provisions of Section 15010 – Mechanical General Conditions.

1.6 QUALITY ASSURANCE

Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance or ASHRAE 111 or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.7 QUALIFICATIONS

A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three (3) years documented experience certified by AABC.

B. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.
1.8 PRE-BALANCING CONFERENCE

Convene one (1) week prior to commencing work of this Section.

1.9 SEQUENCING

Sequence Test and Balance work to commence after complete installation of systems and schedule completion of work before Substantial Completion of Project.

1.10 DESIGN CONDITIONS

A. The HVAC systems have been designed to maintain the inside conditions indicated below when operating with the outside conditions stated. HVAC systems are intended to operate 24 hours a day, year-round, in either occupied or unoccupied mode as described in Specification 15975 and 15985. Install, test, adjust and balance the systems so that they will produce the inside conditions for design. Mechanical Contractor shall be prepared to provide a suitable test to prove that equipment is producing capacities scheduled.

B. Inside Conditions:
   1. Summer: 75 degrees Fahrenheit dry bulb
      55% relative humidity
   2. Winter: 70 degrees Fahrenheit dry bulb

C. Outside Conditions:
   1. Summer: 102 degrees Fahrenheit dry bulb
      72 degrees Fahrenheit wet bulb
   2. Winter: 30 degrees Fahrenheit dry bulb

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 AGENCIES

A. Engineered Air Balance Co., Inc.

B. PHI Service Agency, Inc.

C. Testing Specialties, Inc.

D. Other Acceptable Agencies: Section 15010 – Mechanical General Conditions.
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.

B. Submit field reports. Report defects and deficiencies noted during performance of services that prevent system balance.

C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

B. Drive Assemblies. In the event that the drive assembly requires a change in belts and pulleys, or requires an increase in motor horsepower, it shall be the responsibility of the HVAC Division to:
1. Determine the size of the replacement equipment.
2. Obtain and install the replacement equipment at no additional cost to Owner.

C. Manual Volume Dampers:
1. In all cases, air volumes shall be adjusted by means of manual dampers in the ductwork, not by integral dampers in the terminal outlets or inlets.
2. Duct damper positions shall be marked with permanent-ink markers or black spray paint after the final setting has been made.

3.4 INSTALLATION TOLERANCES

A. Contractor shall adjust all equipment in accordance with the capacities shown on the drawings, with permissible tolerances as follows:

Supply fans 0% to +10%
Return +5% to -10%
Exhaust fans 0% to -10%
Diffusers/supply grilles -5% to +10%
Return grilles 0% to -10%
Exhaust grilles 0% to -10%
Outside Air 0% to +5%

3.5 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

F. Check and adjust systems approximately six months after final acceptance and submit report.

3.6 AIR SYSTEM PROCEDURE

A. Adjust roof top units and distribution components and systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system, including supply register and diffuser blade patterns, to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Provide volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
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. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries. Adjust and set packaged rooftop barometric damper to maintain positive building pressurization. Mark and clearly identify barometric damper setting.

M. 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 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
   1. Fans.
   2. Air Filters.
   3. Air Inlets and Outlets.
   4. VAV Terminal Units.
   5. Packaged Rooftop Units.

3.8 REPORT FORMS

A. Title Page:
   1. Name of Testing, Adjusting, and Balancing Agency.
   2. Address of Testing, Adjusting, and Balancing Agency.
   3. Telephone number of Testing, Adjusting, and Balancing Agency.
   4. Project name.
   5. Project location.
   7. Project Engineer.
   8. Project Contractor.
   9. Report Date.

B. Summary Comments:
   1. Design versus final performance.
   2. Notable characteristics of system.
   3. Description of systems operation sequence.
4. Summary of outdoor air and exhaust flows to indicate amount of building pressurization.
5. Nomenclature used throughout report.
6. Test conditions.

C. Instrument List:
1. Instrument.
2. Manufacturer.
3. Model Number.
4. Serial Number.
5. Range.
6. Calibration Date.

D. Electric Motors:
1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, Voltage, Amperage; Nameplate, Actual, No Load.
5. RPM.
7. Starter Size, Rating, Heater Elements.
8. Sheave Make/Size/Bore.

E. V-Belt Drive:
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.

F. Electric Resistance Heater:
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).
10. Air flow, specified and actual.
11. Temperature rise, specified and actual.

G. 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.
13. Number of Belts/Make/Size.
14. Fan RPM.

H. Return Air/Outside Air Data:
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.
10. Required mixed air temperature.
11. Actual mixed air temperature.
12. Design outside/return air ratio.
13. Actual outside/return air ratio.

I. Exhaust Fan Data:
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.
10. Number of Belts/Make/Size.
11. Fan RPM.

J. Duct Traverse:
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.
K. Duct Leak Test:
   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.

L. Flow Measuring Station:
   1. Identification/number.
   2. Location.
   3. Size.
   4. Manufacturer.
   5. Model number.
   7. Design Flow rate.
   8. Design pressure drop.
  10. Actual/final flow rate.
  11. Station calibrated setting.

M. Air Distribution Test Sheet:
   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.

N. VAV Terminal Unit – Fan Powered:
   1. Terminal Unit number.
   2. Room number/location.
   3. Terminal type.
   4. Terminal size.
   5. Motor horsepower.
   7. Motor amps actual.
   8. Design air flow heating.
   9. Test (final) air flow heating.
10. Percent of design air flow heating.
11. Design air flow cooling.
12. Test (final) air flow cooling.
13. Percent of design air flow cooling.
14. Minimum airflow design.
15. Minimum airflow test (final).
16. Total static pressure (total external), specified and actual.
17. Inlet pressure.
18. Discharge pressure.
19. Refer to 3.8.F. for heater requirements.

O. Packaged Rooftop Unit:
   1. Identification/number.
   2. Location.
   3. Manufacturer.
   4. Model number.
   5. Serial number.
   6. Condensing Section Data:
      a. Entering DB air temperature, design and actual.
      b. Leaving DB air temperature, design and actual.
      c. Number of compressors.
   7. Evaporator Coil Data:
      a. Air flow, design and actual.
      b. Entering air DB temperature, design and actual.
      c. Entering air WB temperature, design and actual.
      d. Leaving air DB temperature, design and actual.
      e. Leaving air WB temperature, design and actual.
      f. Saturated suction temperature, design and actual.
      g. Air pressure drop, design and actual.
   8. Electric Resistance Heater:
      a. Manufacturer.
      b. Identification/number.
      c. Location.
      d. Model number.
      e. Design kW.
      f. Number of stages.
      g. Phase, voltage, amperage.
      h. Test voltage (each phase).
      i. Test amperage (each phase).
      j. Air flow, specified and actual.
      k. Temperature rise, specified and actual.
   9. Evaporator Fan:
      a. Arrangement/Class/Discharge.
      b. Air flow, specified and actual.
      c. Return air flow, specified and actual.
      d. Outside air flow, specified and actual.
      e. Total static pressure (total external), specified and actual.
      f. Inlet pressure.
      g. Discharge pressure.
      h. Sheave Make/Size/Bore.
i. Number of Belts/Make/Size.
j. Fan RPM.

END OF SECTION
SECTION 16000
ELECTRICAL SPECIFICATIONS

1.1 GENERAL

Section 15000 is a part of these Electrical Specifications for New Classrooms and Library Buildings, Southwest Texas Junior College, Eagle Pass, Texas.

1.2 SCOPE

A. Work to be accomplished under these Specifications includes the furnishing of all labor, materials, and equipment required for the complete installation as described herein and as indicated on the Drawings.

B. Work is to be completed from point of service to each outlet indicated on Drawings and/or specified herein with all accessory construction as may be required to make the installation of each piece of equipment complete and ready for normal service. In general, this work consists of the following:

1. A system of power connections to the heating and air conditioning equipment as indicated on the Drawings.

2. A system of power connections to the ventilation equipment as indicated on the Drawings.

3. A system of power and control connections to kitchen equipment and refrigeration equipment as indicated on the Drawings.


5. A system of conduits, junction boxes, pull boxes, outlet boxes with plates, wiring devices, panel boards, lighting fixtures, transformers, conductors, time clocks, and related items for the power and lighting system.

6. A partial system of conduits with Jetline pullcords, junction boxes, pull boxes, outlet boxes with plates, and related items for future telephone and data transmission systems.

7. A partial system of conduits, junction boxes, pull boxes, outlet boxes with plates, and a complete system of speakers, conductors, amplifier, and related items for a complete public address system in the multi-purpose room.

8. A partial system of conduits, outlet boxes with plates, junction boxes, and a complete system of conductors, manual stations, control panel, signaling devices, detectors, and related items for a complete fire alarm system for the new building. A partial system of conduits, outlet boxes with plates, junction boxes, and a complete system of conductors, manual stations, signaling devices, detectors, and related items for complete system extensions from the existing fire alarm system at building “D” addition.

9. A partial system of conduits with Jetline pullcords, junction boxes, pull boxes, outlet boxes with plates, and related items for a future television system.

10. A partial system of conduits, junction boxes, pull boxes, outlet boxes with plates, and related items for an Owner furnished security system.
C. Installation of this work, including all materials and labor shall be first class in every respect and in exact accordance with these Specifications and accompanying Drawings. It is intended that Specifications and accompanying Drawings shall include everything requisite and necessary for proper installation of electric wiring, even though every item may not be particularly mentioned in detail.

1.3 ELECTRICAL SERVICE

A. New service utilization voltage (for new building) shall be solidly grounded, 277/480 volt, 3-phase, 4-wire nominal. Power company will provide service, indicated on Drawings. Contractor shall be responsible for contacting power company for all requirements.

B. Power company construction costs associated with the provision of permanent power shall be paid to the power company by the Owner. Power company costs associated with the provision of temporary construction power shall be paid to the power company by the Contractor.

C. Contractor shall furnish all new service equipment not furnished by power company for a complete installation. Contractor shall provide transformer grounding as directed by the power company.

D. Contractor shall furnish the underground conduit system, and related items for the underground primary system.

E. Contractor shall furnish the pad as indicated on the Drawings for power company owned transformer. Contractor shall obtain transformer pad details from the power company.

F. Contractor shall furnish the secondary feeder complete as indicated on the Drawings.

G. Termination of primary conduit at both ends (transformer and point of service origin) shall be as directed by the power company. Termination of secondary conduit and wiring at the transformer shall be as directed by the power company. Termination of secondary conduit and wiring at the building main shall be as indicated on the Drawings and in these Specifications.

H. Metering will be coordinated and provided in accordance with power company requirements.

I. Existing service utilization voltage for building “D” addition is 120/208 volt, 3-phase, 4-wire nominal. Provide modifications to and extensions from the existing service as indicated and as required.

1.4 TEMPORARY POWER AND LIGHTING

A. Contractor shall provide all necessary wiring, service switches, poles, ground fault protection equipment, etc., required for temporary power and lighting during
construction of the new building. The contractor shall pay all construction related energy charges for construction of the new building.

B. Contractor shall provide all necessary portable/temporary cables, service switches, ground fault protection, etc. required for temporary power and lighting during construction of the building “D” addition. Temporary construction power may be derived from the existing facility distribution system (existing building “D” distribution system) without cost of use charges for the building “D” addition.

1.5 GROUNDING

A. The entire electrical system shall be grounded in accordance with Article 250 of the National Electrical Code, and as hereinafter specified.

B. Main service entrance grounds shall be as indicated on Drawings.

C. Each lighting pole shall have ground rod installed concealed in pole base. All such ground rods shall be installed to have a minimum 7’ direct contact with earth. All poles shall be bonded to ground rod with #6 AWG copper conductor. Ground bonding point shall be accessible from pole hand hole. Lighting poles shall be furnished with factory welded threaded stud adjacent to hand hole for contractor furnished / field installed compression barrel / lug.

D. Driven ground rods shall be provided where required and/or where indicated on the Drawings. Ground rods shall be minimum 3/4" x 10'-0" Copper-weld or equal. All ground wiring shall have adequate mechanical protection, and be exothermically welded to rods.

E. Grounding electrode and equipment conductors with a "green" colored insulated jacket shall be provided and installed in all raceways, whether non-metallic or metallic.

F. Equipment shall have an effective equipment ground in accordance with the National Electrical Code.

G. Furnish and install telephone system grounding, as directed and required by serving telephone equipment supplier and shall comply with Article 800-40 of the National Electrical Code.

H. An isolated grounding conductor shall be furnished for all isolated ground receptacles and electrical gear serving isolated ground receptacles. Isolated ground conductor shall be terminated at isolated ground device terminal at device end and at isolated ground bus at panel end. For isolated ground devices, the equipment ground shall be terminated at device outlet box at device end and at equipment ground buss at panel end.

1.6 CONDUIT AND TUBING

A. Conduit size shall be 1/2" unless otherwise indicated on the Drawings or otherwise specified.
B. Conduit installed underground or in concrete slabs shall be Schedule 40 rigid polyvinyl chloride (PVC) conduit as manufactured by Carlon or approved equal, installed in accordance with National Electrical Code, and as indicated on Drawings. All PVC conduit shall have Underwriters Laboratory, Inc. approval for direct burial underground without concrete encasement. All PVC plastic conduit must be installed in accordance with manufacturer's recommendations and in strict accordance with the applicable sections of these Specifications.

C. Conduit installed above grade in damp or wet locations shall be rigid hot-dip galvanized conduit as manufactured by Republic, Allied, Triangle, Wheatland, Western, or an approved equal, with screwed couplings and fittings. All fittings used shall be hot-dip galvanized.

D. Fittings and connections involving dissimilar metals shall not be allowed in damp or wet locations.

E. All conduit in furred ceiling spaces, interior masonry, or stud partitions and dry locations shall be galvanized thinwall (EMT) with die-cast watertight, insulated throat type compression fittings. Indentor type or set screw type connectors and fittings will not be accepted. All conduit installed in finished spaces shall be concealed unless otherwise specifically indicated on the Drawings.

F. MC type cable is not permissible for use except as specifically permitted by Paragraph 1.6.G.2 of these Specifications. Other types of cable shall not be utilized for any purpose.

G. Flexible metal conduit shall not be used for any purpose except as hereinafter specified and as specifically indicated on the Drawings. All flexible metal conduit shall be installed in strict accordance with Articles 348 and 350 of the National Electrical Code. Non-metallic flexible conduit will not be acceptable for any purpose.
   1. Connections to mechanical and plumbing equipment shall be made with flexible metal conduit. Length of flexible conduit for this application shall not exceed 6'-0".
   2. Flexible metal conduit or MC type cable may be used above ceilings for light fixture connections. Length of flexible conduit for this application shall not exceed 6'-0".
   3. Liquid tight flexible metal conduit shall be used for connection to dry type transformers. Length of flexible conduit for this application shall not exceed 6'-0".
   4. Liquid tight flexible metal conduit with approved fittings shall be used for connection to all hardwired kitchen equipment. Length of flexible conduit for this application shall not exceed 6'-0".
   5. Where flexible conduit is used for connections to equipment in damp or wet locations, conduit shall be liquid-tight flexible metal conduit with approved fittings.
   6. Flexible metal conduit may be utilized in existing wall cavities where the installation of EMT is not feasible. Length of flexible metal conduit beyond existing wall cavities for this application shall not exceed 4'-0".
1.7 INSTALLATION AND ROUTING OF CONDUITS

A. All conduit shall be run in the straightest possible path.

B. Not more than three (3) 90 degree bends will be permitted in any one (1) conduit run and no run shall be longer than allowed by the National Electrical Code without the installation of pull boxes. There shall not be any pull boxes or junction boxes installed in inaccessible space.

C. Exposed steel conduit shall be run in straight lines, at right angles to, or parallel with walls, beams, columns, or decks, and shall be supported at maximum of 6'-0" by malleable conduit straps or suitable clamps on hangers to provide a rigid installation. PVC conduit shall not be run exposed for any application.

D. In no case shall conduit be fastened to other pipe or equipment or so installed as to prevent the ready removal of other pipes or equipment for repairs.

E. All Schedule 40 steel conduit ends are to have a minimum of five full threads. No running threads are to be used. All conduit shall be reamed after cutting and threading and before installation; runs shall be straight and true; elbows, offsets, and bends shall be uniform and symmetrical. All conduit after installation and prior to completion of project shall be capped to prevent entrance of moisture and foreign objects. Conduit shall be swabbed before installation of wire. PVC conduit joints shall be made in accordance with manufacturer's recommendations.

F. Elbows in PVC conduit below grade shall be Schedule 80 PVC.

G. Provision shall be made for expansion and contraction of all conduit as hereinafter specified.

H. Underground PVC conduit shall not be extended above grade. PVC shall be transitioned to Schedule 40 rigid galvanized conduit at level of finished grade or slab for all exterior applications and in damp or wet locations. PVC shall be transitioned to EMT at slab level for all interior applications in dry locations.

I. All underground conduits shall have a minimum cover from top of conduit to finished grade of at least 24".

J. Provide 4" wide yellow warning tape 1'-0" above all underground secondary and communication conduit exterior to building lines. Provide 4" thick red concrete cap over all primary conduit.

K. All steel (vertical rise) conduits and fittings shall be wrapped with 3M pipe wrap. Successive winds of pipe wrap shall be overlapped at least 1". Vertical rise conduit shall be wrapped to at least 6" above finished grade or slab.

L. All grouped conduit (3 or more parallel) installed in accessible space shall be mounted to and supported by B-Line or approved equal channel strut. Strut attachment to building structure shall be made with minimum 1/4" diameter all-thread securely attached to each end of strut and to the building structure above.
in trapeze form. All conduit shall be neatly arranged and securely attached to strut by pipe clamps approved for this application. Strut and fitting sizes shall be as required by the number, size, and weight of conduit and conductors to be supported. Location and elevation of all conduit support structures shall be left to the discretion of the contractor who shall be charged with the responsibility of coordinating all such installations with the locations of mechanical, plumbing, architectural, and structural components. Contractor shall refer to the "General Conditions" paragraph of Section 15000. All components of trapeze hangers shall be hot-dipped galvanized where such hangers are installed in damp or wet locations.

1.8 EXPANSION JOINTS

A. Provision for expansion and shifting of conduits shall be provided where conduit rises from underground or crosses a building expansion joint.

B. Conduits which are freely suspended in space and crossing a building expansion joint shall be considered as having sufficient freedom for any expansion or movement on interior of building.

C. Steel conduit connected to conduit which rises from below grade and terminating in a panelboard, cabinet, switch, or other fixed device shall have expansion fitting installed above grade.

D. All underground conduit which rises up through the floor slab shall pass through a pipe sleeve in the floor to allow any movement between the underground conduit and structural members of the building.

1.9 CONCRETE

All concrete caps shall be ready-mix type transit mix and shall be continuously agitated until poured. Concrete shall be minimum 2,500 pound strength after 30 days and shall have red pigment.

1.10 HANGERS AND SUPPORTS

A. Contractor shall provide all hangers and supports for supporting all conduit, gutters, cabinets, and equipment of all types. All hangers and supports shall be secure and of a type appropriate in design, application, and dimensions for the particular application.

B. Concrete inserts shall be malleable iron concrete inserts. Selection of inserts shall be made with a minimum safety factor of 100% over published load ratings.

C. Perforated hanger strap and wire will not be acceptable for any supporting purpose.

D. Contractor shall submit for approval, mounting details including all mounting hardware and connections to the building structure, for the following electrical fixtures and gear:
   1. Pendant mounted transformers.
2. Ceiling fans.

1.11 PAINTING

Electrical Contractor shall touch-up or refinish if so directed by the Architect any panels, cabinets, switchboards, fixtures, and other equipment furnished with a factory finish which shall become damaged in shipment or installation.

1.12 CONDUCTORS

A. All wiring and cables shall be insulated soft-drawn annealed 98% conductivity copper and shall be new. Voltage rating of wire and cable operating on voltages in excess of 50 volts shall be 600 volts A.C. For circuits operating on voltage less than 50 volts, the voltage rating shall be not less than 300 volts A.C.

B. All wire No. 10 AWG and smaller shall be solid and wire of larger size shall be stranded unless otherwise specified herein. Stranded wire will not be permitted for termination at wiring devices rated 20 amperes or less.

C. Power feeder and branch circuit wire and cables shall have insulation Type THHN unless indicated otherwise on Drawings. Standard wire size shall be No. 12 AWG copper and this size shall be used except where other sizes are indicated on the Drawings, otherwise specified herein, or otherwise required by the Code. On any run 100 feet in length or longer, No. 10 AWG copper shall be used in place of No. 12. Feeder cables shall be identified by suitable tags where they pass through pull boxes. Conductors as manufactured by Cablec, Capitol, American Insulated, Houston Wire and Cable, Southwire, and Okonite will be acceptable.

D. All wire for special systems and special conditions shall be as specified and/or as indicated on the Drawings.

1.13 WIRE PULLING LUBRICANTS

Contractor shall use Ideal “CableEase” or approved equal wire pulling lubricants for all wire installation. Soaps or other substitute material having electrical conduction properties are not acceptable.

1.14 COLOR-CODING AND TAGGING

A. All wiring furnished shall be color-coded. Conductors No. 10 AWG and smaller shall have insulation colored as follows. Conductors larger than No. 10 AWG may be black with tape manufactured for this application and colored as follows. All such conductors shall be color-code taped at all junctions and terminations.

1. 120/208 volt, 3-phase:
   a. Phase A – Black.
   b. Phase B – Red.
   c. Phase C – Blue.

2. 277/480 volt, 3-phase:
   a. Phase A – Brown.
b. Phase B – Orange.
c. Phase C – Yellow.

3. Switched legs:
a. Phase color with white tracer.

4. Conductors for isolated ground branch circuits and feeders:
a. Phase Conductors - Phase color with yellow tracer.
b. Neutral - White with yellow tracer.

5. Ground conductors:
a. Green.

6. Isolated ground conductors:
a. Green with yellow tracer.

B. All control wiring shall be color-coded, and the same color shall be used for the same circuit throughout the system, and a different color shall be used for each separate control function.

C. Identification shall be accomplished by means of Brady "Quick-Labels" or approved equal attached permanently to all wire requiring identification in addition to the color-coding. Acceptable manufacturers: Thomas and Betts, Ideal.

1.15 INSULATION OF SPLICES AND CABLE TERMINATION

All connections for conductors No. 8 and larger must be made by means of a compression type connector UL listed and specifically approved for the purpose for which it is used. Wire No. 10 and smaller may connected with wire nuts in lieu of compression connections, if desired by contractor.

1.16 OUTLET AND SWITCH BOXES

A. All boxes shall be galvanized and shall be set with covers flush and square with the finished surface.

B. Boxes set in plaster finished walls or concrete shall be #52151, 4” square boxes 1 1/2” deep or deeper with 1/2” or 3/4” raised plaster rings as required by device shall be used.

C. Boxes set in concrete block, structural tile, brick, plywood, formica, or other field installed surfaces shall be square cut masonry boxes, and shall have standard square type corners.

D. All boxes shall be securely attached to the structural members by suitable metal bar hangers.

E. Junction boxes and pull boxes shall be furnished where indicated on the Drawings, or as required by the National Electrical Code. Boxes shall be of code gauge galvanized steel, and shall have removable screw cover. Flush boxes shall be used on all walls and ceilings where conduits are concealed. Where conduits are exposed, surface type boxes shall be used.
F. Any boxes not installed in a workmanlike manner shall be removed by contractor, wall repaired, and box reset.

G. Boxes and conduit fittings for outdoor work shall be cast metal, watertight, and have gasketed coverplates.

### 1.17 LOCATION OF OUTLET BOXES

A. Contractor shall determine from the complete dimensioned Architectural Drawings, the electrical details and Drawings, and from other contractors, the locations of all pieces of equipment prior to locating any outlet boxes or devices.

B. All outlet boxes, devices, etc., shall be located so as to be clear of equipment, permanent fixtures, building trim, etc. If the exact location of any equipment is not clearly defined, the contractor shall request direction from the Architect prior to locating the facilities for the equipment.

C. Locations of services for equipment connections shall be determined accurately from certified shop drawings on equipment to be served, or from actual measurements of the equipment itself.

D. All wall outlets for equipment on panel walls shall be located symmetrically with the pattern established by the panels. Determine exact location for all boxes from the Architect before installation.

E. All ceiling outlets shall be located in close cooperation with the air conditioning and the acoustical ceiling, so that outlets will be symmetrical with ceiling pattern established by the air conditioning diffusers and by the acoustical ceiling tile. Final lighting fixture locations shall be as approved by the Architect. All corridor fixtures shall be mounted in a straight line.

F. Outlet boxes for receptacles and light switches shall be mounted with long axis of the box vertical unless otherwise indicated on the Drawings.

G. Size and location outlet boxes for special and/or recessed equipment shall be obtained from the equipment manufacturer supplying the equipment.

### 1.18 HEIGHT OF OUTLETS

A. The following table shall act as a general guide to aid the contractor in locating elevations of outlet boxes where such elevations are not specifically indicated on the Drawings.

<table>
<thead>
<tr>
<th>OUTLET</th>
<th>LOCATION</th>
<th>ABOVE FLOOR TO TOP OF BOX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience Receptacles</td>
<td>Walls in general</td>
<td>18” or as directed by Architect</td>
</tr>
<tr>
<td>Convenience Receptacles</td>
<td>Walls at work benches</td>
<td>42” or as directed by Architect</td>
</tr>
<tr>
<td>Switches</td>
<td>Walls</td>
<td>48” on strike of door</td>
</tr>
</tbody>
</table>
B. The exact location of all outlets shall be as approved by the Architect who reserves the right to change the position of any outlet by a distance of five feet in any direction, from the position indicated on the Drawings before work is roughed-in, without extra charge. Outlet heights are indicated in these Specifications as a guide. Regardless of heights indicated, the contractor is ultimately responsible for confirming that all final outlet locations are in compliance with the requirements of Texas Architectural Barriers Act and Title III Provisions of the Americans with Disabilities Act.

1.19 WIRING DEVICES

Wiring devices, or approved equal, as scheduled and/or indicated on the Drawings shall be furnished and installed. All receptacles shall be grounding type, and shall be polarized in accordance with the latest standards of the National Electrical Code.

1.20 COVERPLATES

A. All coverplates for switches, receptacles and other wiring devices, except as hereinafter specified, shall be satin finish, Type 302 stainless steel, smooth with matching screws.

B. All coverplates shall have matching screws.

C. Coverplates for exterior wiring devices and wiring devices in damp or wet locations shall be rain-tight while-in-use type die cast covers.

1.21 DISCONNECT SWITCHES

A. All disconnect switches shall be Square D Type GD for 240 volt use and Square D Type HD, or approved equal, for 480 volt use, quick-make quick-break type safety switches with cover interlocked door.

B. All switches on exterior of building and in damp or wet locations shall be in NEMA 3R enclosures.

C. All motors and fixed equipment connections shall have disconnects as required by the National Electrical Code.

D. All disconnect switches shall have the load served by the switch identified by 1/8" thick white thermoplastic with black (3/4" stroke) sunken letter nameplate screwed or riveted to outside cover of the switch.

E. Disconnect switches as manufactured by Cutler-Hammer will be acceptable.

1.22 LIGHTING FIXTURES

A. Lighting fixtures as hereinafter specified and as indicated on the Drawings shall be furnished and installed by the contractor. Installation details and scheduled information indicated on the Drawings describe the requirements of each fixture type and shall apply where applicable.
B. Recessed fixtures shall be installed in complete compliance with all applicable codes and with the requirements these Specifications. Outlet boxes shall have bar hangers.

C. Supports of adequate capacity and rigidity shall be provided for all fixtures. Also, refer to "Hanger and Supports" Section of these Specifications.

D. All fixtures in areas with suspended acoustical tile ceilings shall be supported to structural system independent of the acoustical tile suspension system. All fixtures in other type ceilings shall have fixture support independent of the ceiling provided where required by weight or size of the fixtures.

E. Alignment of lighting fixtures and ceiling diffusers shall be carefully coordinated on the job. Where ceiling diffusers are located on ceilings, locate light fixtures symmetrical with diffusers.

F. Continuous row mounting shall be provided as indicated on the Drawings, with the necessary connectors, joining strips, etc., to form a neat compact joint and to maintain a straight line of fixtures.

G. Sealed nickel cadmium high temperature emergency battery units shall be factory installed in fixtures so indicated by scheduled information on the Drawings. Minimum initial illumination of light source shall be 600 lumens. Minimum illumination after 90 minutes of discharge shall be 450 lumens. Maximum full recharge time after 90 minutes discharge shall be 24 hours. Battery unit in standard configuration shall have integral test switch, red LED charge power indicator, constant current charger, high efficiency inverter, and automatic transfer switch for automatic transfer to battery unit upon loss of normal power, and return transfer to normal power upon restoration of normal power. Nickel cadmium battery, charger, inverter, and transfer switch shall be concealed interior to battery unit hosing. LED indicator shall be fixture mounted and shall be visible for inspection from below fixture without removal or opening of fixture parts. Test switch shall be fixture mounted and shall be accessible from below fixture by means of opening fixture door. Battery unit shall be finished in enamel and shall bear the UL seal of approval and battery unit replacement wiring diagram. Fixtures with emergency battery packs shall have unswitched power to battery unit.

H. Contractor shall test all fixtures containing emergency battery packs and submit a report indicating the time and date emergency fixtures were tested, the name of personnel who performed the test, and the results of the test. The test report shall be included within the Operation and Maintenance manual submittal.

I. Lamps shall be furnished for all fixtures. Fluorescent lamps shall be 41K color as manufactured by G.E., Phillips, and Sylvania.

J. Sockets for all fixtures shall be heavy duty type make of high density material with all current carrying parts made of heavy copper. All sockets shall be white in color on all exposed lamp fixtures.
K. All fluorescent ballasts shall be solid-state. Values of voltage rating, input power, output frequency, power factor, and total harmonic distortion shall be equal to the values of ballasts selected by scheduled information on the Drawings.

L. Locations and elevations indicated on the Drawings for exterior wall pack fixtures are intended to serve as a general guide. Contractor shall verify the exact location and elevation of all such fixtures with the Architect prior to the installation of rough-in for same.

M. All directional distribution type fixtures with narrow x long type distribution shall be mounted such that long axis of distribution is parallel with long axis of area to be illuminated.

N. Where wall mounted emergency fixtures (other than exit signage) are located in exposed structure areas, such fixtures shall be located 1'-0" below lowest structural roof members. Where such fixtures are located in areas with ceilings, fixture elevation shall be 6" below ceilings. Where such fixtures are located in spaces which have multi-level ceiling heights and/or structure, all fixtures shall be located at the same elevation (6" below) which shall be established by the lowest ceiling or structural member elevation.

O. Data furnished on lighting fixtures shall indicate specifically by manufacturer their compliance with the above special requirements where applicable. If this information is not provided, the data cannot be accepted.

P. Substitutions may be offered by the contractor, provided the substitute fixture is equal to the specified fixture in performance, physical appearance, mechanical features and efficiency. Contractor shall submit photometric calculations of each space if/as directed by this office to determine equivalency. Contractor shall provide Com-Check interior and exterior lighting reports for approved substitute lighting packages.

1.23 CONTROL EQUIPMENT, WIRING, AND CONNECTIONS

A. Furnish and install all conduit, wire, control connections, and other electrical work in connection with the installation of the kitchen refrigeration equipment. All control devices shall be provided integral to refrigeration equipment. Control wiring and connections for same shall be installed complete in all respects to achieve control as indicated on the approved vendor furnished wiring diagrams. All control wiring shall be installed in conduit.

B. The HVAC contractor shall furnish and install complete automatic temperature control system.

C. Electrical Contractor shall provide power wiring and terminations as required for control equipment furnished and installed by the HVAC Contractor.
1.24 WIRING OF MOTORS

All motors specified under other divisions of the Specifications will be furnished by the respective contractor. Electrical shall provide all power wiring and connections to same. See the Control Equipment, Wiring, and Connections Section of these Specifications.

1.25 CIRCUITING

Contractor shall connect all wires so as to provide the arrangement of circuits indicated on the Drawings.

1.26 IDENTIFICATION AND LABELING OF DISTRIBUTION GEAR

A. Contractor shall furnish white thermoplastic (1/8" thick) with black sunken letters (3/4" stroke) for all panel boards, distribution panel boards, transformers, and disconnect switches. Labels shall be permanently attached to service side of all such gear.

B. Identification and labeling of individual branch circuit devices shall be provided as hereinafter specified.

1.27 SPACES AND SPARES

A. Where spaces are indicated on the Drawings for panel boards, and distribution panel boards, all such spaces shall be completely equipped provisions such that future installation of over-current devices requires no accessory apparatus.

B. Where spares are indicated on the Drawings for panel boards, and distribution panel boards, all such spares shall be completely equipped and line side connected devices, such that future use of same requires load side connection only.

1.28 PANELBOARDS AND CABINETS

A. Contractor shall furnish all panelboards as indicated on Drawings, and riser diagrams. Panelboards shall be of dead-front type and shall be complete with lockable door and trim. Each door shall be equipped with spring latch and tumbler-lock. All locks shall be keyed alike and two keys shall be provided to the Owner for each lock. Cabinets shall be 20” wide code gauge steel and boxes shall be galvanized. Each panel shall have main lugs and/or main breakers as indicated. Branch circuits shall be equipped with bolt-on type automatic circuit breakers for each circuit. Panelboards shall bear the Underwriter's Laboratories, Inc., seal of approval. All panelboards shall have tin plated copper bussing with capacity as indicated. Lugs shall be UL listed to accept solid or stranded copper and aluminum conductors.

B. Panels shall be Square D Type NQ with QOB circuit breakers or equal for 120/208 volt use, and Type NF with EDB circuit breakers or equal for 277/480 volt use. Multi-pole breakers shall be one handle common trip.

C. Panelboards shall have 100% rated copper neutral bus and copper ground bar.
D. Branch circuits as indicated on the Drawings shall be connected to the corresponding breaker number of the panels insofar as possible. Each circuit bearing load shall be identified on a typewritten directory card inside the door of each panel. Spare circuit breakers and spaces shall be hand written in pencil on directory card.

E. Series rating for circuit breakers in panels is not acceptable, all circuit breakers shall be fully rated.

F. Panelboards by Cutler-Hammer will be acceptable.

1.29 DISTRIBUTION PANELS

A. Furnish and install distribution panelboards as indicated on the Drawings. Panelboards shall be dead-front, safety type equipped with thermal magnetic, molded case circuit breakers of frame and trip ratings as indicated on the Drawings.

B. Panelboard bus structure and main lugs or main breaker shall have current ratings as indicated on the Drawings. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50 degree C. rise above ambient. Heat rise tests shall be conducted in accordance with Underwriter’s Laboratories Standards. Buss structure in all distribution panels shall be tin plated copper.

C. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. Front faces of all circuit breakers shall be flush with each other. Each individual circuit breaker shall have circuit number identified by means of white thermoplastic labels (1/8” thick) with black sunken letter (3/4” stroke) permanently attached to panel cover near each respective circuit breaker, spare, and space. This circuit number shall correspond to number on typewritten directory card attached to inside panel door which indicates respective loads. Tripped indication shall be clearly indicated by the breaker handle taking a position between ON and OFF.

D. Each panelboard, as a complete unit, shall have a rating equal to or greater than the integrated equipment rating indicated on the Drawings. Such rating shall be established by test with the circuit breakers mounted on the panelboard. Short circuit tests on the circuit breaker and on the panelboard structure shall be made simultaneously by connecting the fault to each panelboard breaker with the panelboard connected to its rated voltage source.

E. Cabinets shall be surface mounted and shall be equipped with spring latch and tumbler-lock. All locks shall be keyed alike and two keys shall be provided to the Owner for each lock. Doors over 48” long shall be equipped with three-point latch and vault lock. Endwalls shall be removable. Fronts shall be of code gauge full-finished steel with rust-inhibiting primer and baked gray enamel finish. Weatherproof cabinets shall be furnished, as indicated on Drawings.
F. Panelboard interior assembly shall be dead-front. Main lugs shall be front barriered. The end of the bus structure opposite the mains shall be barriered.

G. Panelboards shall be listed by Underwriter's Laboratories and shall bear the UL label. Panelboards shall be suitable for use as service equipment where indicated on the Drawings. Distribution panelboards shall be Square D I-LINE, or approved equal.

H. Panelboards shall have 100% rated copper neutral bus and copper ground bar.

I. Series rating for circuit breakers in distribution panels is not acceptable, all circuit breakers shall be fully rated.

J. Panelboards by Cutler-Hammer will be acceptable.

1.30 GENERAL PURPOSE DRY TYPE TRANSFORMERS

A. The general purpose dry type distribution transformers indicated on the Drawings shall be 3-phase, 60 cycle, air insulated and air cooled, 2-winding, dry type, of the capacity as indicated. Primary shall be 480 volts with standard taps and secondary shall be 120/208Y volts. 480 volt supply is obtained from a grounded wye source and the secondary of the transformer shall be connected to the source neutral.

B. Transformers 25 KVA and above shall be 150 degrees C. temperature rise above 40 degree C. ambient. All insulating materials to be in accordance with NEMA ST20-1972 Standards for a 220 degrees C. UL component recognized insulation system.

C. Transformer coils shall be of the continuous wound construction and shall be impregnated with non-hygroscopic, thermo-setting varnish.

D. Enclosure shall be designed for floor mounting except where wall mounting is indicated on the Drawings. Provide rain shields for all transformers to be installed outdoors. All wiring to the transformer shall be completely enclosed in conduit and the transformer case. Transformers shall meet the latest requirements of the ASA and NEMA, and shall have inorganic silicone insulation for operation of 150 degrees C. temperature rise.

E. Transformer noise levels shall be within standards published by NEMA ST20 and ANSI C89.2. Each transformer conduit connection shall have a 24" section of flexible "Sealtite" conduit adjacent to the transformer to help prevent vibration transmission to the building.

F. Isolation Mounts: Transformers shall be mounted on Korfund Type VPS elastorib damper isolator bases having integral load distribution top plate.

G. Transformers shall be Square D, Cutler-Hammer or approved equal. Provide K-rated isolation transformers, as indicated on Drawings.
H. The grounding conductor for interior transformers shall utilize a CGB connector where such conductor enters the transformer housing. The grounding conductor for exterior transformers shall be protected from the transformer housing to the grounding electrode.

1.31 CONNECTIONS TO EQUIPMENT SPECIFIED ELSEWHERE OR BY THE OWNER

A. Certain equipment will be furnished by the Owner or other contractors on the job which will require electrical services and connections by the Electrical. Contractor shall refer to the "Disconnects", and "Control Equipment, Wiring, and Connections", "Wiring of Motors", and the "Location of Outlet Boxes" Sections of these Specifications.

B. HVAC equipment such as fan powered boxes, packaged rooftop units, ventilation equipment, etc., shall be furnished and installed by the HVAC Contractor. Electrical services indicated on the Drawings are based on the requirements of specified HVAC equipment. Attention is directed that in the event the HVAC Contractor furnishes equipment other than specified, changes may be required to accommodate the electrical load and quantity of electrical connections for such furnished equipment. Electrical Contractor must coordinate changes resulting from differences between the specified and furnished HVAC equipment and advise the HVAC Contractor of any additional costs. HVAC Contractor shall be responsible for paying all costs involved as a result of the changes.

C. Electric water cooler units, water heaters, circulation pumps, and other equipment will be furnished and installed by the Plumbing Contractor. Electrical shall provide electrical connections in accordance with vendor furnished drawings.

D. Certain equipment will be furnished by Owner and under other sections of the Specifications. Equipment connections will be based on vendor furnished drawings, or actual requirements of equipment. This includes door operators, Science equipment, library security gates, etc.

E. Kitchen equipment will be furnished and installed under other divisions of the Specifications. Electrical shall rough-in and make final connections to all kitchen equipment. Rough-in and final connections shall be based upon vendor furnished drawings.

1.32 TELEPHONE AND DATA TRANSMISSION ROUGH-IN SYSTEM

A. Provide a partial telephone and data transmission rough-in system with a Jetline pullcord in each conduit. Minimum conduit size shall be 1”.

B. Conduit shall extend from each rough-in outlet box to point above accessible ceiling, or as indicated.

C. Provide a blank coverplate for all rough-in outlet boxes.

D. Furnish and install service raceways as required by Telephone Company.
1.33 TELEVISION ROUGH-IN SYSTEM

A. Provide partial television rough-in system with Jetline pullcord in each conduit. Minimum conduit size shall be 1”.

B. Conduit shall extend from each rough-in outlet box to point above accessible ceiling, or as indicated.

C. Provide a blank coverplate for all rough-in outlet boxes.

1.34 FIRE ALARM SYSTEM EXTENSIONS – BUILDING “D” ADDITION

A. Attention is directed that the definition of work, materials, and devices required to provide extensions from the existing fire alarm system is dependent upon jobsite observations by the contractor. The contractor shall be responsible for visiting the site and become completely informed of the scope of work required for system extensions prior to submittal of proposal. The contractor shall provide all materials, devices, labor, and accessory apparatus required for system extensions in the amount of the proposal. General fire alarm system extension/modification requirements are indicated on the Drawings for the building addition.

B. All system components and system programming required for compliance with applicable codes and the requirements of the authorities having jurisdiction are hereby included in the contract requirements. The fire alarm system shall receive new state certification prior to substantial completion of the project.

C. Provide connection to and extension from the existing Fire-Lite MS502UD fire alarm control panel as required to serve new devices associated with the new addition. Provide all required control panel apparatus if/as required to serve new devices.

D. Area coverage type smoke detectors, duct type smoke detectors, and manual pull stations shall match existing devices. Jobsite verify type. All new manual pull stations shall be furnished with Stopper II covers.

E. Duct type smoke detectors shall match existing. Jobsite verify type. Duct detectors shall be furnished with relays, visual indicator sampling tubes, and enclosure. Install detectors at locations selected by the HVAC contractor and approved by the authority having jurisdiction.

F. Strobes and horn/strobes shall match existing. Jobsite verify type. Rating of candela output for strobes and horn strobes shall be as required by each respective room size for compliance with Americans with Disability Act intensity requirements. Strobes and horn strobes shall match existing devices. Jobsite verify type.

G. Fire alarm system monitor modules and control/relay modules shall match existing. Jobsite verify type.
H. All fire alarm system devices furnished shall be completely compatible with the existing system.

I. All programming changes and system labeling required to accommodate the system extensions/modifications shall be provided by the contractor.

J. Conduit shall be furnished and installed by the Electrical Contractor. Refer to other sections of these Specifications for conduit requirements.

K. All cable shall be installed in conduit except cable installed above accessible ceilings. All wiring run exposed in plenum space shall be plenum rated cable. All wiring run exposed above ceiling shall be neatly bundled and supported to the building structure at minimum 6'-0" intervals.

L. Where conduit is run from wall mounted outlet boxes to above ceilings and conduit is open-ended above ceilings in non-plenum space, all such raceways openings shall be sealed airtight after cable is installed. All sealing material shall be pliable and readily removable. Where conduit openings are located in plenum space, sealing is not required.

M. Conduit fill shall not exceed 40% of interior cross sectional area where three or more cables are contained within a single conduit.

N. 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 N.E.C. Article 760-29.

O. All wiring shall be new. Provide plenum rated cable where cable is to be installed in plenum space.

P. Wiring shall be in accordance with local, state, and national codes (e.g., N.E.C. Article 760). Number and size of conductors shall be as recommended by the system manufacturer.

Q. Fire alarm system cable shall be 14 AWG or 16 AWG, 2-conductor cable to match other existing cable.

R. Submittals:
1. Prepare and submit all shop drawings and calculations required by the authorities having jurisdiction and these Specifications.
2. Fire alarm shop drawing submittal shall include, but not limited to, floor plan drawings locating and naming each device. Control panel configuration including wiring and interconnection schematics as required by Texas Insurance Code, Article 5.432.
3. Factory data sheets on each piece of equipment to be used and so marked as to model, dimensions, size, voltage, and configuration.
4. Fire alarm equipment and devices indicated on the Drawings and specified herein are intended to illustrate the general extent and character of system requirements. Specific wiring between equipment/devices has not been indicated. Location and quantity of devices indicated are intended to be used as general guide. It is the
Contractor's responsibility to submit for approval the complete designed system configuration and layout indicating all devices, wiring, conduit, and locations along with other required information as specified herein for the system proposed for installation.

5. Calculations for the power supplies and batteries.
6. All submittal data shall be in bound form with Contractor's name, project name, and State Fire Alarm License Number of Installer.
7. Operation and Maintenance Manuals. Provide the following:
   a. As-Built Drawings locating and assigning device address (as programmed) for each device.
   b. Complete operating and maintenance instruction manuals.
   c. Point-to-point wiring as installed for reference and instructional use.
   d. Complete Bill of Material for reference and recommended spare parts.
   e. Programming matrix defining all input/output functions and zoning.

1.35 ACCESSORY CONSTRUCTION APPARATUS

It is the intention that these Specifications shall provide a complete installation, except as herein specifically excepted. All accessory construction and apparatus necessary or advantageous in the operation or testing of the work shall be included. Omission of specific references to any part of the work necessary for such complete installation shall not be interpreted as relieving the contractor from furnishing such work.

1.36 TESTS/Demonstration

A. The entire system upon completion shall be "Meggered" for faults in accordance with methods approved by I.E.E.E. and National Electrical Code if so directed by the Engineer.

B. A demonstration shall be performed in the presence of a representative of the Architect. Equipment installed and/or connected by the contractor shall be put through their normal operating paces and all such equipment shall be required to operate to the satisfaction of the Architect on completion of the job.

1.37 INSTRUCTIONS

Contractor shall provide for instructing an employee or employees of the Owner in the operation and maintenance of the systems. Duplicate sets of manufacturer's certified drawings, specifications, operating instructions, maintenance manuals, and maintenance instructions on all equipment furnished by contractor shall be furnished to the Owner.

1.38 WORKMANSHP AND INSTALLATION

A. Contractor shall have his choice as to the location of conduits, pull boxes, etc., except for locations set by dimensions on Drawings, provided his choices do not interfere with piping, fixtures, and equipment installed by other contractors working on the same project, and do not interfere with the characteristic features
of the building. In cases of such interference, the Architect will determine the locations of the interfering items.

B. Contractor shall make such progress in his work that he will not delay the work of other trades unduly.

C. Contractor shall provide service to all using connections.

D. Cutting of any structural member, regardless of material, shall be kept at a minimum. Contractor shall pay for repairing damage to such members.

E. All electrical fixtures and fittings of all types shall be properly supported to construction.

END OF SECTION
SECTION 16100
FIRE DETECTION AND ALARM SYSTEM

1.1 GENERAL

A. Sections 15000 and 16000 are a part of these Specifications for New Classrooms and Library Buildings, Southwest Texas Junior College, Eagle Pass, Texas. All applicable conditions and requirements of Sections 15000 and 16000 and conditions of the contract shall apply to this Section of the Specifications.

B. 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 indicated on the Drawings and specified herein.

C. Fire alarm system shall comply with requirements of the latest adopted version of the NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this Specification. The system shall be electrically supervised and monitor the integrity of all conductors.

D. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

E. Fire alarm control panel and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).

F. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

1.2 SCOPE

A. A new intelligent reporting, microprocessor controlled fire detection and alarm system shall be furnished and installed in accordance with the Contract Documents for the New Classrooms and Library Buildings.

B. Basic Performance:
   1. Alarm, trouble, and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
   2. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC circuit.
   3. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.
   4. Digitized electronic signals shall employ check digits or multiple polling.
   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.
C. Basic System Functional Operation:

1. When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:
   a. The system alarm LED on the fire alarm control panel shall flash.
   b. A local piezo electric signal in the control panel shall sound.
   c. A backlit 80 character LCD display on the fire alarm control panel and remote annunciators shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
   d. The fire alarm control panel history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
   e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
   f. Shut down air handling equipment as required by applicable codes.
   g. Activate auto dialer (digital alarm communicator/transmitter) to place call (pre-programmed message) to the proper emergency agency.

1.3 SUBMITTALS

A. Fire alarm equipment and devices indicated on the Drawings and specified herein are intended to illustrate the general extent and character of system requirements. Specific wiring between equipment/devices has not been indicated. Location and quantity of devices indicated are intended to be used as general guide. It is the Contractor's responsibility to submit for approval the complete designed system configuration and layout indicating all devices, wiring, conduit, and locations along with other required information as specified herein for the system proposed for installation.

B. Prepare and submit all shop drawings and calculations required by the authorities having jurisdiction.

C. Fire alarm shop drawing submittal shall include, but not limited to, floor plan drawings locating and naming each device. Control panel configuration including wiring and interconnection schematics as required by Texas Insurance Code, Article 5.432.

D. Factory data sheets on each piece of equipment to be used and so marked as to model, dimensions, size, voltage, and configuration.

E. Equipment manufactured by Notifier shall be considered as meeting these Specifications and as the standard of quality. All prospective bidders proposing a substitute system must comply with prior approval requirements as mandated by Architectural Sections of the Specifications.

F. Calculations for the power supplies and batteries.
G. All submittal data shall be in bound form with Contractor's name, project name, and State Fire Alarm License Number of Installer.

H. Operation and Maintenance Manuals. Provide the following:
   1. As built shop drawings showing all installed devices, schematic cable routing, and the as programmed address of each addressable device.
   2. Complete operating and maintenance instruction manuals.
   3. Point-to-point wiring as installed for reference and instructional use.
   5. Programming matrix defining all input/output functions and zoning.

1.4 SOFTWARE MODIFICATIONS

Provide all hardware, software, programming tools, and documentation necessary for future modification of the fire alarm system software on site by the Owner. Modification includes addition and deletion of devices, circuits, zones, and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of future software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

1.5 WARRANTY

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of Final Acceptance. Full cost of maintenance, labor, and materials required to correct any defect during this one (1) year period shall be included in the submittal bid.

1.6 POST CONTRACT MAINTENANCE

A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the warranty.

B. As a part of submittal data, include written commitment that the services of a factory trained and authorized technician will be available to perform future system software modifications, upgrades, or changes. Commitment shall state that response time of the technician to the site shall not exceed 24 hours.

1.7 POST CONTRACT EXPANSIONS

Contractor shall have the ability to provide parts and labor to expand the system specified, if so requested, for a period of five (5) years from the date of acceptance.

1.8 APPLICABLE STANDARDS AND SPECIFICATIONS

A. Specifications and standards listed below form a part of this Specification. The system shall fully comply with the latest adopted version of the following applicable standards.
B. National Fire Protection Association (NFPA) - USA:
   No. 72 National Fire Alarm Code
   No. 101 Life Safety Code

C. International Building Code including International Fire Code and all applicable
   standards/codes adopted by reference.

D. Underwriters Laboratories, Inc. (UL) - USA:
   No. 268 Smoke Detectors for Fire Protective Signaling Systems.
   No. 864 Control Units for Fire Protective Signaling Systems.
   No. 268A Smoke Detectors for Duct Applications.
   No. 464 Audible Signaling Appliances.
   No. 38 Manually Actuated Signaling Boxes.
   No. 346 Waterflow Indicators for Fire Protective Signaling
      Systems.

E. Local and State Building Codes.

F. Americans with Disabilities Act.

G. Texas Accessibility Standards.

H. All requirements of the Authority Having Jurisdiction (AHJ).

1.9 EQUIPMENT AND MATERIAL, GENERAL

A. All equipment and components shall be new, and the manufacturer’s current
   model. Materials, appliances, equipment, and devices shall be tested and listed
   by a nationally recognized approvals agency for use as part of a protective
   signaling system, meeting the National Fire Alarm Code.

B. All equipment and components shall be installed in strict compliance with
   manufacturer’s recommendations. Consult the manufacturer's installation
   manuals for all wiring diagrams, schematics, physical equipment sizes, etc.,
   before beginning system installation.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be
   held firmly in place (e.g., detectors shall not be supported solely by suspended
   ceilings). Fasteners and supports shall be adequate to support the required
   load.

1.10 WIRE AND CONDUIT

A. Conduit shall be furnished and installed by the Electrical Contractor. Refer to
   Section 16000 for conduit requirements.

B. Wiring installed in inaccessible space and wiring exposed to view in unfinished
   spaces, such as mechanical rooms and storage areas, shall be installed in
   conduit. Wiring installed above accessible ceilings may be run exposed. All
wiring run exposed in plenum space shall be plenum rated cable. All wiring run exposed where cable tray or J-hooks are available shall be installed in cable tray or J-hooks. All wiring run exposed where cable tray of J-hooks are not available shall be neatly bundled and supported to the building structure at minimum 6'-0" intervals.

C. Where conduit is run from wall mounted outlet boxes to above ceilings and conduit is open-ended above ceilings in non-plenum space, all such raceway openings shall be sealed airtight after fire alarm cable is installed. All sealing material shall be pliable and readily removable. Where conduit openings are located in plenum space, sealing is not required.

D. Conduit fill shall not exceed 40% of interior cross sectional area where three (3) or more cables are contained within a single conduit.

E. 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 N.E.C. Article 760-29.

F. All fire alarm system wiring shall be new.

G. Wiring shall be in accordance with local, state, and national codes (e.g., N.E.C. 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 No. 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and No. 14 AWG (1.63 mm) for Notification Appliance Circuits.

H. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

I. 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).

J. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. In certain applications, the system shall support up to SLCs with up to 1,000 feet of untwisted, unshielded wire. Design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.

K. All field wiring shall be electrically supervised for open circuit and ground fault.

L. Fire alarm control panel shall be capable of T-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems which do not allow or have restrictions in, for example, the amount of T-taps, length of T-taps etc., are not acceptable.

M. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.
N. 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.

O. Fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit and all associated appurtenances shall be furnished and installed by the Electrical Contractor. This circuit shall be labeled at the branch circuit panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be No. 12 AWG. Control panel cabinet shall be grounded in accordance with Article 250 of the N.E.C. Grounding shall be furnished and installed by the Electrical Contractor.

1.11 MAIN FIRE ALARM CONTROL PANEL

A. Fire alarm control panel shall be a NOTIFIER Model NFS-640 or approved equal and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal detectors, addressable manual stations, addressable control modules, notification devices, printer, annunciators, and other system controlled devices.

B. Operator control shall be as follows:
   1. Acknowledge Switch: Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
   2. Depression of the acknowledge switch shall also silence all remote annunciator piezo sounders.
   3. Alarm Silence Switch: Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. Selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards. Fire alarm control panel software shall include silence inhibit and auto-silence timers.
   4. Alarm Activate (Drill) Switch: Alarm activate switch shall activate all notification appliance circuits. Drill function shall latch until the panel is silenced or reset.
   5. System Reset Switch: Activation of the system reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.
   6. Lamp Test: Lamp test switch shall activate all system LEDs and light each segment of the liquid crystal display, and display the panel software revision for service personal.

C. System Capacity and General Operation:
   1. Control panel shall provide, or be capable of expansion to 636 intelligent/addressable devices.
2. Control panel shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 2.0 amps @ 30 VDC. It shall also include four (4) Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notification Appliance Circuits.

3. The system shall support up to eight (8) additional output modules (signal, telephone, or relay), each with eight (8) circuits for an additional 64 circuits. These circuits shall be either Class A (NFPA Style Z) or Class B (NFPA Style Y) as required.

4. Fire alarm control panel shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.

5. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel. The system shall be fully programmable, configurable, and expandable in the field without the need for special tools, PROM programmers, or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.

6. The system shall allow the programming of any input to activate any output or group of outputs. Systems which have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer will not considered as acceptance substitutes.

7. Fire alarm control panel shall provide the following features:
   a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
   b. Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.
   c. Maintenance alert, with two (2) levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
   d. Nine sensitivity levels for alarm, selected by detector. Alarm level range shall be 0.5 to 2.35% per foot for photoelectric detectors and 0.5 to 2.5% per foot for ionization detectors. The system shall also include up to nine (9) levels of pre-alarm, selected by detector, to indicate to maintenance personnel of impending alarms.
   e. The ability to display or print system reports.
   f. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
   g. PAS pre-signal, meeting NFPA 72 3-8.3 requirements.
   h. Rapid manual station reporting (under 3 seconds).
   i. Non-alarm points for general (non-fire) control.
   j. Periodic detector test, conducted automatically by the software.
   k. Self-optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its pre-alarm level to just above normal peaks.
l. Cross zoning with the capability of counting: two (2) detectors in alarm, two (2) software zones in alarm, or one (1) smoke detector and one (1) thermal detector.
m. Walk test, with a check for two (2) detectors set to same address.
n. Control-by-time for non-fire operations, with holiday schedules.
o. Day/night automatic adjustment of detector sensitivity.
p. Device blink control for sleeping areas.
q. UL 1076 security monitor points.

8. Fire alarm control panel shall include as integral device, Digital Auto-Dialer (Digital Alarm Communicator/Transmitter). Factory installation shall include everything requisite to proper communication/transmission of emergency message. Fire Alarm Contractor shall furnish and install Cat. 5, 4-pair UTP cable from auto-dialer to telephone company telephone board. Cable shall be tagged "Digital Alarm Communicator/Transmitter". Final termination at the telephone board shall be by the Communications Contractor. All required programming of auto-dialer shall be by the Fire Alarm Contractor.

9. Fire alarm control panel shall be capable of coding notification circuits in march time (120 PPM), temporal (NFPA 72 A-2.2.2), and California code. Main panel notification circuits (NAC 1, 2, 3, and 4) shall also support special two and three stage operations. The two stage feature allows 20 pulses per minute (PPM) on alarm and 120 PPM after five (5) minutes or when a second device activates. The three stage option provides 20 PPM with one (1) detector in alarm, 120 PPM with two (2) detectors in alarm, and steady on with release.

D. Central Microprocessor:
1. Microprocessor shall be a high speed, 16 bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, flash memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
2. Microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
3. Microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. Time-of-day and date shall not be lost if system primary and secondary power supplies fail. Real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.
4. A special program check function shall be provided to detect common operator errors.
5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
6. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download, and have the ability to upgrade the manufacturers (flash) system code changes. This program shall also have a verification utility which scans the program.
files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

E. Display:
1. The display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
3. The display shall include an 80-character back-lit alphanumeric Liquid Crystal Display (LCD). It shall also provide eight (8) Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PRE-ALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, and ALARM SILENCED.
4. The 80-character display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two (2) different password levels shall be provided to prevent unauthorized system control or programming.
5. The display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.
6. The system shall support an optional battery ammeter/voltmeter display.

F. Signaling Line Circuits (SLC):
1. The system shall include two (2) SLCs. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a system capacity of 318 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
2. Central processing unit (CPU) shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, pre-alarm, or trouble conditions exist for each detector. Software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. Analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
3. Detector software shall meet NFPA 72, Chapter 7 requirements and be certified by UL as a calibrated sensitivity test instrument.
4. Detector software shall allow manual or automatic sensitivity adjustment.
G. Serial Interfaces:
1. The system shall include two (2) Serial EIA-232 interfaces. Each interface shall be a means of connecting UL listed Electronic Data Processing (EDP) peripherals.
2. One EIA-232 interface shall be used to connect an UL listed 40 or 80 column printer.
3. The second EIA-232 interface shall be used to connect a UL listed CRT terminal. This interface shall include special protocol methods that allow off-site monitoring of the fire alarm control panel over standard dial-up phone lines. This ancillary capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade fire alarm control panel operations when used. It shall allow remote fire alarm control panel Acknowledge, Reset, or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.
4. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
5. The EIA-485 interface may be used for network connection to a proprietary receiving unit.

H. Notification Appliance Circuit (NAC) Module:
1. Notification appliance circuit module shall provide four (4) fully supervised Class A or B (NFPA Style Z or Y) notification circuits. An expansion circuit board shall allow expansion to eight (8) circuits per module.
2. Notification circuit capacity shall be 3.0 amperes maximum per circuit and 6.0 amperes maximum per module.
3. Module shall not affect other module circuits in any way during a short circuit condition.
4. Module shall provide eight (8) green ON/OFF LEDs and eight (8) yellow TROUBLE LEDs.
5. Module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
6. Each notification circuit shall include a custom label inserted to identify each circuit’s location. Labels shall be created using a standard typewriter or wordprocessor.
7. Notification circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. Terminal strips shall be UL listed for use with up to No. 12 AWG wire.
8. Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.

I. Control Relay Module:
1. Control relay module shall provide four (4) Form-C auxiliary relay circuits rated at 5 amperes, 28 VDC. An expansion circuit board shall allow expansion to eight (8) Form-C relays per module.
2. Each relay circuit shall be capable of being activated (change in state) by any initiating device or from any combination of initiating devices.
3. Relay module shall provide eight (8) green ON/OFF LEDs and eight (8) yellow LEDs (indicates disabled status of the relay).
4. Module shall provide a momentary switch per relay circuit that may be used to manually turn the relay ON/OFF or to disable the relay.
5. Each relay circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or wordprocessor.
6. Control relay module shall be provided with removable wiring terminal blocks for ease of installation and service. Terminal blocks shall be UL listed for use with up to No. 12 AWG wire.

J. Enclosures:
1. Control panel shall be housed in a UL listed cabinet suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer’s standard finish.
2. Back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be selected for either right or left hand hinging.

K. Power Supply:
1. Main power supply for the fire alarm control panel shall provide 6.0 amps of available power for the control panel and peripheral devices.
2. Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
3. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other overcurrent protection shall be provided on all power outputs. Power supply shall provide an integral battery charger for use with batteries up to 55 AH or may be used with an external battery and charger systems. Battery arrangement may be configured in the field.
4. Main power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:
   a. Ground Fault LED.
   b. Battery Fail LED.
   c. AC Power Fail LED.
   d. NAC on LED (4).
5. Main power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the fire alarm control panel.
6. Main power supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge.
7. Main power supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
8. Main power supply shall provide meters to indicate battery voltage and charging current.
9. All circuits shall be power-limited, per 1995 UL 864 requirements.

L. Field Charging Power Supply:
1. Remote Power Supplies: Field charging power supplies shall be Notifier FCPS-24S. Power supplies shall be furnished and installed if/as required to serve notification appliance loads. All power supplies shall be installed at readily accessible locations. Power supplies shall not be installed in visible locations within occupiable spaces. Power
connections to remote power supplies shall be provided by the Electrical Contractor as required. Coordination of power services for remote power supplies shall be coordinated with the Electrical Contractor by the Fire Alarm Contractor prior to submittal of proposal.

2. Field charging power supply is a device designed for use as either a remote 24 volt power supply or used to power notification appliances.

3. Field charging power supply shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60 hour standby.

4. Field charging power supply shall have two (2) input triggers. Input trigger shall be a notification appliance circuit (from the fire alarm control panel) or a relay. Four (4) outputs (two (2) Style Y or Z and two (2) style Y) shall be available for connection to the notification devices.

5. Field charging power supply shall include an attractive surface mount backbox.

6. Field charging power supply shall include the ability to delay the AC fail delay per 1993 NFPA requirements.

7. Field charging power supply include power limited circuitry, per 1995 UL standards.

M. Specific System Operations:

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.

2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. Alarm verification delay shall be programmable from five (5) to thirty (30) seconds and each detector shall be able to be selected for verification. Fire alarm control panel shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.

4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
   a. Device status.
   b. Device type.
   c. Custom device label.
   d. View analog detector values.
   e. Device zone assignments.
   f. All program parameters.

5. System Status Reports: Upon command from an operator of the system, a status report will be generated and logged, listing all system status.

6. System History Recording and Reporting: Fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Each of these activations will be stored and time and date stamped with the actual time of the activation. Contents of the
history buffer may be manually reviewed, one event at a time. History buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.

7. Automatic Detector Maintenance Alert: Fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

8. Pre-Alarm Function: The system shall provide two (2) levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.

9. Software Zones: Fire alarm control panel shall provide 100 software zones, 10 additional special function zones, 10 releasing zones, and 20 logic zones.

10. Fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:
   a. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for three (3) seconds.
   b. Introducing a trouble into the initiating device shall activate the programmed outputs for eight (8) seconds.
   c. Walk test shall be selectable on a per device/circuit basis. All devices and circuits which are not selected for walk test shall continue to provide fire protection and if an alarm is detected, will exit walk test and activate all programmed alarm functions.
   d. All devices tested in walk test shall be recorded in the history buffer.

N. Waterflow Operation: An alarm from a waterflow detection device shall activate the appropriate alarm message on the eighty (80) character display, turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.

O. Supervisory Operation: An alarm from a supervisory device shall cause the appropriate indication on the eighty (80) character display, light a common supervisory LED, but will not cause the system to enter the trouble mode.

P. Signal Silence Operation: Fire alarm control panel shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.
Q. Non-Alarm Input Operation: Any addressable initiating device in the system may be used as a non-alarm input to monitor normally-open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

R. Combo Zone: A special type code shall be available to allow waterflow and supervisory devices to share a common addressable module. Waterflow devices shall be wired in parallel, supervisory devices in series.

1.12 SYSTEM COMPONENTS

A. Alphanumeric LCD Type Remote Annunciator:
1. Alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. LCD annunciator shall display all alarm and trouble conditions in the system.
3. An audible indication of alarm shall be integral to the alphanumeric display.
4. The display shall be UL listed for fire alarm application.
5. It shall be possible to connect up to thirty-two (32) LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
6. Annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a 2-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
7. The system shall allow a minimum of thirty-two (32) terminal mode LCD annunciators. Up to ten (10) LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence, and Reset which shall be protected from unauthorized use by a keyswitch or password.

1.13 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

A. Addressable Devices - General:
1. Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range from 001 to 159.
2. Addressable devices which use a binary-coded address setting method, such as a DIP switch, are not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable, and shall connect with two (2) wires to the fire alarm control panel signaling line circuits.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. Fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity shall be automatically adjusted by the panel on a time-of-day basis.

6. Using software in the fire alarm control panel, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. Detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

7. Detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.

8. Detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the fire alarm control panel based on real-time measured values. Fire alarm control panel software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the fire alarm control panel program and allowing the system operator to view the current analog value of each detector.

11. Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.

12. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.

13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

B. Field Devices:

1. Intelligent Duct Detector: Notifier Model FSD-751P series duct mounted "intelligent" photoelectric smoke detectors shall be provided. Detectors shall operate on the same principles and exhibit the same basic characteristics as area type "intelligent" smoke sensors.

2. Smoke Detectors: Fire alarm area coverage type smoke detectors shall be Notifier FSP-851. Detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

3. Heat Detector: Fire alarm thermal detector shall be Notifier FST-851. Thermal detectors shall be intelligent addressable devices rated at 135
degrees F. (57 degrees C.) and have a rate-of-rise element rated at 15 degrees F. (8.3 degrees C.) per minute. It shall connect via two (2) wires to the fire alarm control panel signaling line circuit.

4. Addressable Manual Stations: Notifier Model NBG-12LX manual stations shall be provided. Addressable manual station shall connect with two (2) wires to one of the intelligent control panel loops. Manual station shall, on command from the control panel, send data to the panel representing the state of the manual switch. Provide Stopper II with horn on all stations.

5. Monitor Module: Notifier Model FMM-1 addressable monitor modules shall be provided to interface to contact alarm devices. Monitor module shall be used to connect a supervised zone of conventional initiating devices (any N.O. dry contact device, including 4-wire smoke detectors) to an intelligent SLC loop. Monitor module shall mount on a 4” square electrical box. Each zone shall be wired Class B.

6. Control Module: Notifier Model FCM-1 control/relay modules shall be provided, to provide audible alarm interface and/or relay control interface. Control module shall be used to connect a supervised zone of conventional indicating devices (any 24 volt polarized audio/visual indicating appliance) to an intelligent loop. Control module will mount in a standard 4” electrical box. The zone shall be wired Class B. Control module may be optionally wired as dry contact (Form C) relay.

7. Isolator Module: Isolator modules shall be Ditek Model DTK-LVLP-F, provided to automatically isolate wire-to-wire short circuits on an SLC loop. Isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section of the SLC loop.

8. Visual alarm shall be adjustable candela System Sensor SR (c). Provide wall mounted and ceiling mounted type devices as indicated on the Drawings. Rating of candela output shall be as required by each respective room size for compliance with Americans with Disability Act intensity requirements.

9. Horn/Strobe: Fire alarm horn/strobe shall be adjustable candela, adjustable sound level System Sensor P2R (c). Provide wall mounted and ceiling mounted type devices as indicated on the Drawings. Strobe shall have candela output rating as required by each respective room size for compliance with the Americans With Disabilities Act intensity requirements. Decibel output of each device shall be as required by audibility requirements of applicable codes. All field wiring connections shall be made via terminal connections.

10. Auxiliary HVAC Relays: Notifier Model FRM-1 addressable relays shall be provided for control and interface of all air handling units so indicated on the Drawings.

11. Exterior fire alarm horns shall be Notifier HRK.

12. Sprinkler and Standpipe Valve Supervisory Switches: Valve supervisory switches shall be furnished and installed by the Plumbing Contractor. Connection of same to the fire alarm system shall be by the Fire Alarm Contractor.
13. Waterflow Indicator: Waterflow switches shall be furnished and installed by the Plumbing Contractor. Connection of same to the fire alarm system shall be provided by the Fire Alarm Contractor.

1.14 BATTERIES

A. Batteries shall be 25 amp/hour sealed Gel Cell type, 12 volt nominal (two required).

B. Battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours plus five (5) minutes of alarm upon a normal AC power failure.

C. Batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

1.15 INSTALLATION

A. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

B. All fire detection and alarm system devices, control panels, and remote annunciators shall be flush mounted.

C. Manual pull stations shall be semi-flush mounted where indicated on the Drawings, and shall be installed not less than 42", nor more than 48" above the finished floor.

1.16 TEST

A. 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, Chapter 7.

B. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

C. Close each sprinkler system flow valve and verify proper supervisory alarm at the fire alarm control panel.

D. Verify activation of all waterflow switches.

E. Open initiating device circuits and verify that the trouble signal actuates.

F. Open and short signaling line circuits and verify that the trouble signal actuates.

G. Open and short notification appliance circuits and verify that trouble signal actuates.

H. Ground all circuits and verify response of trouble signals.
I. Check presence and audibility of tone at all alarm notification devices.

J. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

K. 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 fire alarm control panel and the correct activation of the control points.

L. Check all interlocks with the smoke control system to verify proper control of smoke zones as indicated on the Drawings and as hereinbefore specified.

M. 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.

1.17 FINAL INSPECTION

At the final inspection, a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect. The system shall be run through simulated detection and alarm sequences in the presence of a representative of the Architect. The system must be demonstrated to the satisfaction of the Architect prior to final acceptance. Time and date of demonstration shall be that which is approved by the Architect.

1.18 INSTRUCTION

A. A minimum of six (6) hours of instructional sessions shall be provided to personnel of the Owner to educate the Owner in proper operation, maintenance, and programming of the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided. Time and date of instructional sessions shall be selected by the Owner.

B. Contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

END OF SECTION
SECTION 16200
MULTI-PURPOSE ROOM PUBLIC ADDRESS SYSTEM

1.1 GENERAL
A. Sections 15000 and 16000 are a part of these Specifications for New Classrooms and Library Buildings, Southwest Texas Junior College, Eagle Pass, Texas. All applicable conditions and requirements of Sections 15000 and 16000 and conditions of the contract shall apply to this Section of the Specifications.
C. The Contractor shall furnish all equipment, accessories, and material required for the public address system for the Multi-Purpose Room in the New Classroom and Library Building. Any material and/or equipment necessary for the proper installation and operation of the system, which is not specifically called for or described herein, shall be deemed part of this Specification.

1.2 MANUFACTURER
The manufacturer shall be a United States manufacturer, who has been regularly engaged in the manufacture of communication systems for at least twenty (20) years. The equipment described herein, and furnished per these Specifications, shall be the product of a single manufacturer. TOA model numbers and other descriptive data are intended to establish minimum required standards of design, function, performance, and quality.

1.3 QUALIFICATIONS FOR APPROVAL AS EQUAL
A. Equipment manufactured by TOA shall be considered as meeting these Specifications and as the standard. All prospective bidders proposing a substitute system must comply with prior approval requirements as mandated by architectural sections of the Specifications. Any prior approval does not exempt a substitute from meeting the full intent of these Specifications. If a substitute system fails to provide all the requirements specified in this document, the contractor shall be responsible for all costs associated with the removal and replacement of such equipment.
B. Systems that do not use industry standard 8 ohm speakers with 25V line matching transformers will not be accepted.
C. The system shall be furnished and installed by the manufacturer's authorized contractor who is qualified in the proper installation, operation, and service of the system. Certification shall be submitted verifying that the contractor is the manufacturer's authorized contractor.
D. Upon request of the Architect/Engineer, any system proposed as an equal shall be made available for demonstration. The date and time of demonstration shall be coordinated with the Architect/Engineer and the end-user.

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1.4 SUBMITTALS

A. The intercommunication and public address systems shop drawing submittal shall include, but not be limited to, wiring and interconnection schematics factory data sheets on each piece of equipment and device to be used and so marked as to model, dimensions, size, voltage, and configuration.

B. Only basic equipment and device locations have been indicated on the Drawings. Specific wiring between equipment/devices has not been indicated. It is the Contractor's responsibility to submit for approval the complete designed system configuration and layout indicating typical devices, wiring, and interconnection schematics, along with other required information as specified herein for the system proposed for installation.

C. All submittal data shall be in bound form with Contractor's name and project name.

1.5 EQUIPMENT WARRANTY

The Contractor shall warrant the equipment to be new and free from defects in material and workmanship, and will, within one (1) year from the date of final acceptance, repair or replace any equipment found to be defective at his (the contractor's) sole expense.

1.6 SERVICE FACILITIES

The contractor shall make available and maintain a satisfactory service department capable of furnishing equipment inspection and service. The Contractor shall be prepared to offer a service contract for the maintenance of the system beyond the warranty period.

1.7 FINAL INSPECTION

At the final inspection, a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect. The system shall be run through simulated sequences and functions in the presence of a representative of the Architect. The system must be demonstrated to the satisfaction of the Architect prior to final acceptance. Time and date of demonstration shall be that which is approved by the Architect.

1.8 INSTRUCTION

A. A minimum of two (2) hours of instructional session shall be provided to personnel of the Owner to educate the Owner in proper operation, maintenance, and programming of the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided. Time and date of instructional sessions shall be selected by the Owner.

B. Contractor and/or the system’s manufacturer’s representatives shall provide a typewritten “Sequence of Operation.”
1.9 SPEAKERS

A. Ceiling mounted recessed speaker assembly shall be Soundolier FAP82T or approved equal speaker with an 8” coaxial cone design providing a frequency response of 65Hz – 20kHz. Speakers shall be recessed and mounted with baffle, tile bridge, and back box. Provide 18 gauge twisted stranded and jacketed cable between each interconnected speaker and to the amplifier. Use plenum rated cable if cable is not installed in conduit.

B. System field wiring diagrams shall be provided to the subcontractor by the system manufacturer prior to installation.

1.10 WIRING AND CONDUIT

A. Conduit shall be furnished and installed by the Electrical Contractor. Coordinate all required conduit installation with Electrical Contractor prior to submission of proposal. Refer to Section 16000 for conduit requirements.

B. Wiring installed in inaccessible space and wiring exposed to view in unfinished spaces such as mechanical rooms and storage areas shall be installed in conduit. Wiring installed above accessible ceilings may be run exposed. All wiring run exposed in plenum space shall be plenum rated cable. All wiring run exposed shall be neatly bundled and supported to the building structure at minimum 6'-0" intervals.

C. Where conduit is run from wall mounted outlet boxes to above ceilings and conduit is open-ended above ceilings in non-plenum space, all such raceways opening shall be sealed airtight after cable is installed. All sealing material shall be pliable and readily removable. Where conduit openings are located in plenum space, sealing is not required.

D. Conduit fill shall not exceed 40% of interior cross sectional area where three or more cables are contained within a single conduit.

E. 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 N.E.C. Article 760-29.

F. All wiring shall be new.

G. Wiring shall be in accordance with local, state, and national codes (e.g., N.E.C. Article 760). Number and size of conductors shall be as recommended by the system manufacturer.

1.11 PUBLIC ADDRESS SYSTEM

A. The wall mount mixer/amplifier shall be a TOA W912A or approved equal having a power rating of 120 watts. It shall be of modular design to allow for maximum design flexibility. The amplifier shall contain a built-in 10 band equalizer. The unit shall be surface mounted. The amplifier shall provide 8 module connector
slots, 6 of which can be configured utilizing input modules as required for system design. The amplifier shall be equipped with an auxiliary input module for a portable program source. It shall be the contractor’s responsibility to select the proper quantity and type of modules necessary to comply with the operational requirements of the Specification.

B. Provide microphone outlets as indicated on the Drawings. Floor outlets shall be Soundolier MRB-1-13 or equal. Wall outlets shall be Soundolier 501-13C or equal. Provide three (3) microphones. Microphones shall be Sure Bros. Model 588SD-LC or equal. Provide four (4) microphone cords. Microphone cords shall be Sure Bros. Model C25J or equal. Provide three (3) Atlas/Soundolier Model MS-10C or equal floor stands and three (3) Atlas/Soundolier Model DS-7 or equal desk stands. Provide 22 gauge twisted stranded and shielded-jacketed cable from each microphone to the amplifier. Use plenum rated cable if cable is not installed in conduit.

C. Provide conductors and speakers as indicated on the Drawings and as hereinbefore specified.

D. Provide one (1) transmitter and four (4) receivers as a packaged assisted listening system in Cafetorium. Assistive listening system package shall be Telex SM-2 with the optional SMC case or approved equal. Provide an output jack for the assistive listening system on or near the public address system amplifier.

END OF SECTION