PROJECT MANUAL

HVAC System Replacement
Newport News Public Schools
Mary Passage Middle School
Newport News, Virginia

IFB #014-0-2024/SNB

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NEWPORT NEWS PUBLIC SCHOOLS

MJT Project No. 22-113

January 26, 2024

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SECTION 000002 - PROJECT DIRECTORY

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END OF SECTION 000115

SECTION 000820 - SPECIAL CONDITIONS

A. SAFETY

1. State Occupational Safety and Health Standards apply to this project. The Owner and Engineer shall not be held responsible for enforcement of safety conditions. Particular attention to the following subparts must be observed:

    a. Ladders and Scaffolds: All ladders, scaffolds, or temporary work platforms to be kept in locked storage or removed from the job site when not in use or when unattended.

    b. Cranes, Hoists, Elevators, and Conveyors: Cranes are to be guarded and/or secured at all times when on the job site so as to avoid becoming a hazard to the public and employees.

        1) Material hoists, lifts, or conveyors are to be secured so as to avoid becoming a hazard when unattended.

    c. Motor Vehicles and Mechanized Equipment: Keys must be removed and secured from vehicles and other mobile equipment when not in use or unattended.

        1) Vehicles and mobile equipment with door locking capability will be locked when not in use.

    d. Demolition: Pay particular attention to safe procedures for demolition and removal of debris so as not to create a hazard to the public and employees. The disposal of solid waste in open dumps is prohibited.

    e. Additional Safety Requirements: No firearms, alcohol, or drugs may be brought onto the project at any time.

        1) All poisonous or otherwise hazardous material will be kept in locked containers when not in use or left unattended.
        2) Contractor’s personnel will strictly adhere to all traffic regulations, traffic patterns, and speed limits.
        3) If any hot work, including but not necessarily limited to welding, burning, or torch cutting, is required, the Contractor will station a watchman inside the building with proper fire extinguisher equipment.

2. Applicable Standards and Codes:

    a. Wherever reference is made to any published standards, codes, or standard specification, it shall mean the latest standard code, specification, or tentative specification of the technical society, organization, or body referred to, which is in effect at the date of Invitation for Bids. The following is a partial list of typical abbreviations which may be used in the specifications and the organizations to which they refer:

ANSI - American National Standards Institute
ASTM - American Society for Testing and Materials
UL - Underwriters Laboratory
NEC - National Electrical Code
USBC - Uniform Statewide Building Code (Virginia)
VBPVRR- Virginia Boiler and Pressure Vessel Rules and Regulations

3. Fire Protection:

   a. The Contractor shall not use flammable liquids or gases, stoves, salamanders, tar pots, etc., in and on the building unless approved by the Engineer. Where welding, cutting, or burning are necessary, incombustible shields shall be used, and suitable fire extinguishing equipment shall be maintained nearby. Paints, oils, turpentine, and similar materials shall be stored in well-ventilated spaces, and no other materials shall be stored therein. The arrangement for storage must have written approval of the Owner. The Contractor shall provide and maintain an adequate number of fire extinguishers throughout the construction period. Free and unobstructed access shall be maintained at all times to fire extinguishing equipment and fire hydrants.
   b. The Contractor shall designate a regular supervisory employee as a Fire Warden, and he shall be responsible for all fire prevention, fire protective matters, and posting of fire protection procedures at the work site.

4. Prevention of Nuisance from Noise, Etc.:

   a. The Contractor shall be responsible for curtailing noise, smoke, fumes, or other nuisances resulting from his operations within the limitations set by law and as directed by the Owner or Engineer.

5. Permits:

   a. Attention is called to license charges and fees pertaining to construction work, as levied by local governments. Such charges and fees, based on the amount of contracted work, are the responsibility of the Contractor. Such permits include but are not limited to hauling materials, dumping materials, and crossing roads with utilities. All crossings of roads shall be bore crossings unless otherwise agreed to by the Department of Transportation Resident Engineer. The Contractor is also responsible for paying all taxes applicable to the project.

6. Temporary Facilities:

   a. The Contractor shall coordinate with Owner Representative for location of trailers, storage, and portable toilet at the pre-construction meeting.
   b. The Contractor shall control workers at all times. Workers are not to use school lounges or telephones.
   c. When possible, parking areas for construction employees in the vicinity of the project site

will be allocated. The Contractor is responsible for informing his employees that they cannot park in any location other than the allocated areas. All existing parking regulations will be enforced. Control of vehicles on the site is the responsibility of the Contractor.

d. Construction fencing, where required, must be adequate to protect persons and property.

7. Utility Outages:

a. The Contractor shall not disrupt traffic, utilities, or the normal daily operation of the school nor produce excessive dust, noise, or fumes without prior Owner Representative coordination and permission.

b. Authority for power outages must be obtained from the Engineer, who will coordinate the interruption of service with the Contractor and the City parties affected. In general, a request for interruption to service will require at least 21 working days for approval.

8. Lead Paint:

a. Lead paint issues may arise during the Project. Contractor shall have properly trained contractors and subcontractors that are able to safely perform work even if lead paint may be present at some locations. Newport News Public Schools will provide testing for lead based paint using an X-ray Fluorescence (XRF) Spectrum analyzer. The Contractor shall conduct any further testing necessary to be in compliance with the OSHA Lead in Construction Standard consistent with 29 CFR 1926.62. The Contractor shall be required to comply with EPA Renovate Repair and Paint (RRP) Rule for pre-1978 child occupied facilities. Lead safe work practices shall be used when disturbing any painted surface with detectable lead using an XRF Spectrum Analyzer. Newport News Public Schools agree that there is no present belief that there will be a need to abate lead paint during the Project. If lead abatement becomes a requirement, Newport News Public Schools will determine the appropriate course of action which may include abatement or removal of an area from the Scope of Services.

9. Temporary HVAC Requirements:

a. Contractor shall be responsible for all temporary cooling, heating, and dehumidification equipment to maintain the space temperature and humidity below the maximum limits of 78°F DB and 60% RH. Provide equipment with capacity as shown on the project drawings.

b. Temporary cooling, heating, and dehumidification equipment shall be provided for the Library.

END OF SECTION 000820

SECTION 010200 - PROJECT SCHEDULE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 PURPOSE

A. The Contractor shall begin work on the date to be specified on the Owner's written "Notice to Proceed" and shall substantially complete the project before July 31, 2024. The Contractor shall pay as liquidated damages the sum of $1,000.00 per day for each consecutive calendar day thereafter for which the project is not substantially complete.

The Contractor shall achieve final completion of the project before August 19, 2024. The Contractor shall pay as liquidated damages the sum of $1,000.00 per day for each consecutive calendar day thereafter for which the project has not achieved final completion.

The Contractor can perform work during any period of time from the Notice to Proceed date and the substantial completion dated noted above, provided the following requirements are met:

- Prior to beginning work on site, the contractor shall present a complete project schedule to the Owner that outlines the intended construction schedule during the occupied and unoccupied periods.
- Any work completed during the occupied periods, shall not disrupt the activities of the students, staff, and operations of the facility.
- All spaces shall be heated or conditioned prior to staff and students returning to the space. If permanent HVAC equipment is not available, the Contractor shall provide temporary cooling or heating as required.
- The Contractor may work during nights, weekends and holidays to complete the project.

1.3 DETAILED DESCRIPTION OF WORK

A. The "Work" generally includes but is not limited to the following:

1. Replace internal components of Air Handling Units.
2. Replace Kitchen combined supply and exhaust fan.
3. Replace chiller and chilled water pumps.
4. Replace condenser water pumps.
5. Remove plate and frame heat exchanger.

6. Replace existing boilers with condensing boilers and convert the hot water system from temperatures of 180°F/160°F to 140°F/110°F.
7. Replace variable air volume boxes with series fan powered variable air volume boxes with hot water coils sized for new lower temperatures.
8. Replace all units with hot water coils, including but not limited to cabinet unit heaters and duct heating coils.
9. Replace exhaust fans and roof intake hoods.
10. The installation of Bipolar ionization units in all air handling units.
11. Replace the building automation system with HONEYWELL controls to be provided by a Honeywell Authorized Controls Integrator. This includes the NIAGRA/JACE web server platform.
12. Install controllers for all new and existing units for new building automation system.
13. Provide Commissioning for all new mechanical units and controls.
14. All required electrical work to support the mechanical scope.
15. Removal and reinstallation of ceiling grid as required to support the mechanical and electrical scope.
16. Professional cleaning of existing ductwork to remain.

Contractor shall visit the site and explore the existing conditions prior to bidding. Contractor shall be aware of potential damage to building, sidewalks, roadways, and landscaping in determining the method for removal and installation of equipment. Contractor shall take special care in protecting trees that may interfere with the removal and installation of equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 010200

SECTION 010800 - CODE OF CONDUCT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section specifies administrative and procedural requirements for the prescribed Code of Conduct while working on school premises.

1.3. CONDUCT

A. The following rules shall apply at all times that students, faculty and staff are on the premises:

1. Owner's Representatives are on site to assist the Contractor (and his subcontractors) in coordination of the Work at the school, and with any required interaction between school personnel. They shall be the only means of communication between the Contractor (and his subcontractors) and persons at the school, except in life threatening emergencies.
2. Minor first-time violation of this relationship will result in a warning or removal from the project. Repeated violations will result in removal from the project.
3. Construction workers shall under no circumstances consult with the school principal and / or teachers regarding any issue of a construction nature, except as noted above.
4. All Contractors (subcontractors) shall wear a colored identification badge while on school premises. Failure to do so is reason for removal from the Job Site.
5. The General Contractor will distribute and maintain badges in accordance with County guidelines.
6. Fraternization between construction workers and teachers or students is strictly prohibited. Any contact deviating from normal courteous behavior will be considered reason for removal from the project.
7. If any student or teacher persist in disrupting the activities of construction work, the Owner's representative shall be notified immediately. Any work proceeding at the direction of a teacher, administrator or staff may result in the work being undone, corrected in accordance with the Contract Documents, or no compensation to the contractor.
8. Use of vulgar, suggestive or abusive language is strictly prohibited in the presence of or within earshot of teachers, students, school administrators or staff.
9. Consumption of alcohol or alcohol containing beverages is strictly prohibited on school grounds.
10. Use and / or possession of any controlled substance or substances considered to be illegal are strictly prohibited on school grounds. Any violation will result in removal from the project, and violator shall be turned over to the proper authorities.

11. Use and / or possession of any firearms or weapons considered to be illegal are strictly prohibited on school grounds. Any violation will result in removal from the project, and violator shall be turned over to the proper authorities.
12. Cigarette smoking is prohibited on school grounds.
13. The use of personal radios / stereos is not permitted.
14. Construction workers shall only use the restrooms designated by the Owner for use by construction workers.
15. Contractors shall park in designated areas only.
16. All construction materials and equipment shall be safely secured and stored when not in use.
17. Any demolition work shall not cause any disruption of communication or fire alarm system in occupied areas.
18. All construction work shall be performed to minimize disruption to any school activity. This may require the contractor to schedule work during off peak hours and shall be accounted for by the contractor during scheduling and included within the bid. Any conflicts shall be brought to the attention of the Architect and Owner's representative prior to proceeding with the work.
19. Construction workers are not permitted free access to the school: Access shall be limited to specific task of construction in designated areas only. The school shall not be used as a shortcut from one portion of construction Work to another, unless specifically designated as a construction route by the Contract Documents or the Owner's representative. This shall apply at all times during the Work without exception.
20. Adequate temporary lighting shall be provided in all demolished / construction areas, including provisions for parking areas which remain in use subsequent to removal of fixtures.
21. Fire exits may not be blocked. (except as indicated in the documents, and as directed by the local authority having jurisdiction)
22. School dumpsters are not for construction debris. The contractor shall provide suitable equipment for prompt and safe removal of all construction debris.
23. Adequate ventilation must be maintained during welding or torch cutting procedures. In addition, spark screens shall be used, and adequate fire extinguishing equipment shall be present. All standard safety procedures shall be observed.
24. Appropriate barricading, fencing and signage shall be used to clearly indicate areas of on-going construction, material storage, or any other condition that may create an unsafe environment for non-construction workers.
25. The Contractor is responsible for the safety, security, and cleanliness of all school property which may remain in the assigned areas of construction.
26. For the Contractor's protection, he may solicit the confirmation of the quantity, quality, etc. of the items of concern with the Owner's representative prior to occupancy. Any shortages or damages noted upon returning to the area of the school shall be considered the Contractor's responsibility. This is of special concern in areas where items (such as athletic equipment) are stored. This shall also include, but not be limited to, damage to carpet, vinyl floor, painted walls, blackboards, bulletin boards, clocks, speakers and furniture.
27. Eating from the school cafeteria is not permitted.
28. Fumes from work that occurs adjacent to HVAC intake or exhaust areas shall be blocked so that they do not enter into the HVAC system.

1.4 RESPONSIBILITIES

A. Contractor's responsibilities shall include but not be limited to the following:

1. Owner's Representatives shall be informed and kept advised of all construction activities at the school. They will assist the Contractor in coordination of the Work effecting school systems, such as electrical, mechanical, plumbing, telephone, etc.
2. A minimum 48-hour notice is required prior to disruption of utilities or services to the school.
3. Owner's Representatives shall be informed and kept advised of the schedule for classroom turnover, and the need to have spaces vacated for construction.
4. Owner's Representatives shall be kept advised of any disruptions or concerns that develop at the school, or with any persons at the school not related to the construction.
5. The General Contractor shall have an authorized and qualified representative, project manager or superintendent on the site at all times during which Work is proceeding. No exceptions.

1.5 SPECIAL COORDINATION AND COOPERATION

A. Owner Occupancy of Existing School Facility: The Owner may occupy all or portions of the existing school facility outside of the construction contract limits for each phase of the construction during some of the construction period. The Contractor shall cooperate with the Owner during the construction period to minimize conflicts and facilitate Owner's usage of the building / premises.

B. The Contractor shall be responsible for scheduling Work so as not to interfere with the Owner's normal operations.

C. To best facilitate the continued operation of the school (while in session), determine with the Owner a general sequence of construction.

D. Generally, renovations shall be accomplished when areas are vacant or when school is not in session, with full access to the building unless noted otherwise.

E. Where isolating work areas requires closing off existing exit-ways, work shall be coordinated with the Owner and the Fire Marshall, providing and maintaining safe egress from the building.

F. Certain items / materials indicated for removal shall be salvaged and turned over to the Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 010800

SECTION 011100 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DRAWINGS ACCOMPANYING PROJECT MANUAL

A. The Drawings accompanying this Project Manual are listed immediately following the Table of Contents in this Project Manual.

1.3 PROJECT DESCRIPTION

A. The “Work” generally includes but is not limited to the following:

Base bid as designated on the Bid Form

1. Replace internal components of Air Handling Units.
2. Replace Kitchen combined supply and exhaust fan.
3. Replace chiller and chilled water pumps.
4. Replace condenser water pumps.
5. Remove plate and frame heat exchanger.
6. Replace existing boilers with condensing boilers and convert the hot water system from temperatures of 180°F/160°F to 140°F/110°F.
7. Replace variable air volume boxes with series fan powered variable air volume boxes with hot water coils sized for new lower temperatures.
8. Replace all units with hot water coils, including but not limited to cabinet unit heaters and duct heating coils.
9. Replace exhaust fans and roof intake hoods.
10. The installation of Bipolar ionization units in all air handling units.
11. Replace the building automation system with HONEYWELL controls to be provided by a Honeywell Authorized Controls Integrator. This includes the NIAGRA/JACE web server platform.
12. Install controllers for all new and existing units for new building automation system.
13. Provide Commissioning for all new mechanical units and controls.
14. All required electrical work to support the mechanical scope.
15. Removal and reinstallation of ceiling grid as required to support the mechanical and electrical scope.
16. Professional cleaning of existing ductwork to remain.

1.4 PERMITS, FEES AND CHARGES

A. General: The Contractor shall obtain and pay for all applicable permits, fees and charges, not specifically excluded from the Contract and not specifically indicated to be obtained and paid for by the Owner.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 011100

SECTION 011400 - CONTRACTOR'S USE OF THE PREMISES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

A. Work Included: This Section applies to situations in which the Contractor or his representatives, including but not necessarily limited to suppliers, subcontractors, employees, and field engineers, enter upon the Owner's property.

1.3 QUALITY ASSURANCE

A. Promptly, upon award of the Contract, notify all pertinent personnel regarding requirements of this Section.

B. Require that all personnel who will enter upon the Owner's property certify their awareness of and familiarity with the requirements of this Section.

1.4 SUBMITTALS

A. Staff Names: Within 15 days of Notice to Proceed, submit a list of the Contractor's principal staff assignments, including the Superintendent and other personnel in attendance at the site; identify individuals, their duties and responsibilities; list their addresses and telephone numbers.

B. Post copies of the list in the temporary field office.

1.5 GENERAL

A. Construction areas of the building will be vacated during the construction period of Summer 2024.

B. Permission to interrupt utility service or gain access to the building shall be requested 7 calendar days in advance. Power outages must be coordinated with Owner a minimum of 21 days prior to the outage.

C. Limit use of the premises to construction activities in areas indicated. Portions of the site beyond areas in which construction operations are indicated are not to be disturbed.

D. The Contractor shall protect all improvements which are to remain from damage. All improvement and ground areas damaged during construction shall be restored to like new work. All sidewalks, parking lot surfaces, and curbs shall be protected from the work. Any damaged surfaces shall be restored to new condition.

E. The Contractor shall limit staging areas to prevent scattering of construction materials and equipment throughout site. The Contractor shall indicate at the Pre-Construction meeting the location and limits of staging areas that he anticipates utilizing for approval by Owner.

F. Keep driveways and entrances serving the premises clear and available to the Owner and the Owner's employees at all times. Do not use these areas for parking or storage of materials.

G. Park in designated pre-approved areas only.

H. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.

I. Maintain the building in a weather-tight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period. Where removal of existing roof construction is necessary to accomplish the Work, have all material and labor ready to provide adequate and approved watertight temporary covering of exposed areas at the end of each day until work is complete.

J. The Contractor shall strictly prohibit weapons, drugs, and tobacco products in all school buildings and property. The Contractor shall restrict and instruct all personnel at the project site that talking to students and/or teachers as well as using school telephones is prohibited. A dress code which requires all construction personnel to wear shirts at all times (without slogans) will be strictly enforced.

1.6 CONTRACTOR'S VEHICLES

A. Parking for Contractor's vehicles, vehicles belonging to employees of the Contractor, and all other vehicles entering upon the Owner's property in performance of the Work of the Contract shall only use the parking and access route as authorized by the Owner.

1.7 SECURITY

A. Restrict the access of all persons entering upon the Owner's property in connection with the work to the access route and to the actual site of the work. Employees of all Contractors shall be required to display a photo identification badge at all times while on Newport New Public Schools property.

1.8 OWNER OCCUPANCY

A. The Owner will occupy the site and all facilities located at the site during the entire period of construction. The Contractor shall cooperate fully with the Owner and any of his representatives during construction operations to minimize conflicts and to facilitate the Owner's usage of the facilities. The Contractor shall perform the work so as not to interfere with the Owner's usage and other facility operations.

1.9 CONTRACTOR'S USE OF EXISTING BUILDINGS

A. Use of the building will not be permitted, except in the actual area of the work. The Contractor shall not allow the use of the Owner's telephone by the Contractor's personnel, subcontractor personnel, or other persons entering upon the Owner's buildings in connection with the work unless otherwise specified.

1.10 PROJECT SCHEDULE AND PHASING

A. Refer to Section 010200, "Project Schedule".

1.11 RECORD OF EXISTING DAMAGE

A. Prior to beginning work, the Contractor shall photograph or video tape all existing damage to building surfaces, finishes, furniture, equipment, and any other property left in the area of work. A copy of the record video, documentation, and photographs shall be provided to the Owner prior to beginning work. The Contractor shall be responsible for repair or replacement of all property damaged as a result of the Contractor's work. Should a dispute occur, the video tape, documentation, or photographs shall be used to settle the dispute. Any damage not documented shall be considered the Contractor's responsibility. Contractor shall verify the operation of all devices removed to facilitate the construction, including but not limited to speakers, clocks, motion detectors, smoke detectors, light fixtures, etc.

1.12 TIME OF WORK

A. Construction work may be done between the hours of 6:00 A.M. and 5:00 P.M., Monday through Thursday. With the Owner's prior approval, work may be done between the hours of 7:00 A.M. and 5:00 P.M., Friday, Saturday and Sunday.

1.13 SYSTEM SHUTDOWNS

A. The Contractor shall schedule the work in such a manner as to complete the work so that system downtime will be at a minimum. Under no circumstances shall the Contractor shut down any systems without Owner's approval.

B. The Contractor shall not interfere with the operation of equipment and services in those areas of the facility where work is not scheduled and where the Owner, employees, and others occupy the facility, facilities, and/or site.

C. The Owner's representative shall be informed at least 7 calendar days in advance of each scheduled shutdown. The Owner shall approve the shutdown schedule in writing.

1.14 CONTRACTOR'S DUMPSTER

A. Contractor shall provide and dump regularly a minimum 10 cubic yard dumpster on site during the construction period for construction debris disposal.

1.15 MANNER OF CONDUCTING THE WORK

A. Daily Cleanup: The Contractor shall regularly clean up work in a manner consistent with this Specification. The Contractor shall provide daily cleanup of dust and debris to preclude the potential of contamination of new materials and equipment or existing equipment. All building entrances, corridors, sidewalks, and exterior pavement shall be cleaned of debris and materials daily to provide clean and unobstructed vehicular and walk paths. The work shall be so executed, and such temporary facilities furnished, as to preclude interference with access within and between the existing building areas and structures and to cause no possible interference with the operation of any essential service thereof. If daily cleanup is not performed to the satisfaction of the Owner, the Owner reserves the right to perform cleanup after 24 hours' notice and back-charge Contractor at rate of $30.00 per hour.

B. Existing Utilities and Equipment: Do not operate or disturb the setting of valves, switches, or electrical equipment on the service lines to the building, and service within the building, except by proper previous arrangement with the Owner and in the presence of the Owner or his authorized representative.

C. Coordination: Coordinate demolition and installation of temporary and permanent utilities with the Owner. Schedule this work so as to cause no disruption of existing building operation and minimum delay of the work. Notify the Owner a minimum of 7 calendar days in advance of anticipated utility outages (21 days for power outages), and schedule such work so as not interrupt normal school operations. Coordinate with the City of Newport News to ensure that all underground utilities are marked prior to start of work by Dominion Energy Virginia. Coordinate with the City of Newport News Fire Marshal all fire system work and adhere to all requirements of the Fire Marshal for protection of the building.

D. Damage to Existing Facilities: Restore existing work, including concealed work not indicated or specified to be modified, and which is damaged or otherwise affected by the Contractor's operations, to a condition equal to that which existed before the work was commenced. Use workmanlike manner where new construction adjoins, connects to, or abuts existing work. Join new work to existing work in such a manner as to make the joining as inconspicuous as possible. Obvious patching of damaged work will not be acceptable. At the completion, ensure that the buildings and grounds are in first-class condition within the intent of these

Specifications, with all new parts well joined to the old as required, all connections completed, and all facilities in full working condition.

E. Protection of Existing Floors, Desks, Carpets, Chairs, and Cabinetry and Other Furnishings: Protect all existing floors, carpets, desks, chairs, cabinetry, chalkboards, tackboards, and any other attached or unattached furnishings in the project areas with a minimum 6-mil polyethylene sheeting. Secure polyethylene sheeting to baseboards to protect floors. Protect wall finishes as required by construction activities. Wall finishes damaged by the attachment of protective sheeting shall be repaired and painted to match surrounding surfaces. Carpet shall be protected with a minimum of two layers of 6-mil polyethylene sheets. The contractor shall cover all Smart Boards with cardboard and a minimum 6-mil polyethylene sheeting. The contractor shall be responsible for any damage done to the existing finishes and furniture.

F. Prior to beginning work, the Contractor shall photograph or video tape all existing damage to building surfaces, finishes, furniture, equipment, HVAC equipment, lights, computers and peripherals, intercom, security system, computer drops, and any other property left in the area of work. A copy of the record video and photographs shall be provided to the Owner prior to beginning work. The Contractor shall be responsible for repair or replacement of all property damaged as a result of the Contractor's work. Should a dispute occur, the video tape or photographs shall be used to settle the dispute. Any damage not documented shall be considered the Contractor's responsibility.

G. Final Cleaning: Provide professional cleaners using commercial quality building maintenance equipment and materials to clean the building in accordance with Section 017400, "Final Cleaning", prior to the date of Substantial Completion.

H. Containment: Maintain containment barriers of the project areas as indicated and as required to preclude construction-generated dust and dirt from entering non-construction areas.

I. In the event the Contractor does not comply with the construction documents, the Owner may procure the services of another qualified Contractor and deduct his costs from the Contract amount.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 011400

SECTION 012000 - APPLICATIONS FOR PAYMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment.

B. Coordinate the Schedule of Values and Applications for Payment with the Contractor's Construction Schedule, List of Subcontracts, and Submittal Schedule.

C. The Contractor's Construction Schedule and Submittal Schedule are included in Section "Submittals".

1.3 SCHEDULE OF VALUES

A. Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.

B. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:

1. Contractor's construction schedule
2. Application for Payment form
3. List of subcontractors
4. List of products
5. List of principal suppliers and fabricators
6. Schedule of submittals

C. Submit the Schedule of Values to the Engineer within ten (10) days after receipt of the Notice to Proceed, unless otherwise directed by the Owner.

D. Use the Project Manual Table of Contents as a guide to establish the format for the Schedule of Values.

E. Include the following Project identification on the Schedule of Values:

1. Project name and location

2. Name of the Engineer
3. Project number
4. Contractor's name and address
5. Date of submittal

F. Arrange the Schedule of Values in a tabular form with separate columns to indicate the following for each item listed:

1. Generic name
2. Related Specification Section
3. Name of subcontractor
4. Name of manufacturer or fabricator
5. Name of supplier
6. Change Orders (numbers) that have affected value
7. Dollar value
8. Percentage of Contract Sum to the nearest one-hundredth percent, adjusted to total 100 percent.

G. Provide a breakdown of the Contract Sum in accordance with requirements of the General Conditions and in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Break principal subcontract amounts down into several line items.

H. Round amounts off to the nearest whole dollar; the total shall equal the Contract Sum.

I. For each part of the Work where an Application for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed, provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

J. Margins of Cost: Show line items for indirect costs, and margins on actual costs, only to the extent that such items will be listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete including its total cost and proportionate share of general overhead and profit margin.

K. At the Contractor's option, temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown as separate line items in the Schedule of Values or distributed as general overhead expense.

L. Schedule Updating: Update and resubmit the Schedule of Values when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.4 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by the Engineer and paid for by the Owner.

B. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.

C. Payment Application Times: Each progress payment date is as indicated in the General Conditions. The period of construction Work covered by each Application or Payment is the period indicated in the General Conditions.

D. Payment Application Forms: Use AIA Document G 702 and Continuation Sheets G 703 as the form for Application for Payment.

E. Application Preparation: Complete every entry on the form, including notarization and execution by person authorized to sign legal documents on behalf of the Owner. Incomplete applications will be returned without action.

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions have been made.
2. Include amounts of Change Orders and Construction Change Directives issued prior to the last day of the construction period covered by the application.

F. Transmittal: Submit 3 executed copies of each Application for Payment to the Engineer by means ensuring receipt within 24 hours; one copy shall be complete, including waivers of lien, invoices for stored on site material, and similar attachments, when required.

G. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to the Architect.

H. Waivers of Mechanics Lien: With each Application for Payment submit waivers of mechanics liens from subcontractors or sub-subcontractors and suppliers for the construction period covered by the previous application.

1. Submit partial waivers on each item for the amount requested, prior to deduction for retainage, on each item.
2. When an application shows completion of an item, submit final or full waivers.
3. The Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of Work covered by the application who could lawfully be entitled to a lien.

I. Waiver Forms: Submit waivers of lien on forms, and executed in a manner, acceptable to Owner.

J. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of the first Application for Payment include the following:

1. List of subcontractors
2. Schedule of Values
3. Contractor's Construction Schedule (preliminary if not final)

4. Submittal Schedule (preliminary if not final)
5. Copies of building permits
6. Copies of authorizations and licenses from governing authorities for performance of the Work.
7. Initial progress report
8. Report of pre-construction meeting
9. Certificates of insurance and insurance policies
10. Performance and payment bonds (if required)
11. Data needed to acquire Owner's insurance

K. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment; this application shall reflect any Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

1. Administrative actions and submittals that shall proceed or coincide with this application include:

a. Occupancy permits and similar approvals
b. Test/adjust/balance record
c. Maintenance instructions
d. Start-up performance reports
e. Change-over information related to Owner's use, operation and maintenance.
f. Final cleaning
g. Application for reduction of retainage, and consent of surety
h. Advice on shifting insurance coverages
i. List of incomplete Work, recognized as exceptions to Architect's Certificate of Substantial Completion.
j. Waivers of Mechanics Liens
k. Items required by the General Conditions

L. Final Payment Application: Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:

1. Completion of Project closeout requirements.
2. Completion of items specified for completion after Substantial Completion.
3. Assurance that unsettled claims will be settled.
4. Assurance that Work not complete and accepted will be completed without undue delay.
5. Transmittal of required Project construction records to Owner.
6. Proof that tax, fees and similar obligations have been paid.
7. Removal of temporary facilities and services.
8. Removal of surplus materials, rubbish and similar elements.
9. Final waiver of Mechanics Liens.
10. Items required by the General Conditions.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 012000

SECTION 012500 - PRODUCT SUBSTITUTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for handling requests for substitutions made after award of the Contract.

B. The Contractor's Construction Schedule and the Schedule of Submittals are included under Section 013300, "Submittals".

C. Standards: Refer to Section 014219 "Reference Standards and Definitions" for applicability of industry standards to products specified.

D. Procedural requirements governing the Contractor's selection of products and product options are included under Section 018700 "Materials and Equipment".

1.3 DEFINITIONS

A. Definitions used in this Article are not intended to change or modify the meaning of other terms used in the Contract Documents.

B. Substitutions: Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the Contractor after award of the Contract are considered requests for "substitutions." The following are not considered substitutions:

1. Substitutions requested by Bidders during the bidding period, and accepted prior to award of Contract, are considered as included in the Contract Documents and are not subject to requirements specified in this Section for substitutions.
2. Revisions to Contract Documents requested by the Owner.
3. Specified options of products and construction methods included in Contract Documents.
4. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

1.4 SUBMITTALS

A. Substitution Request Submittal: Requests for substitution will be considered if received within 30 days after commencement of the Work. Requests received more than 30 days after commencement of the Work may be considered or rejected at the discretion of the Engineer.

B. Submit 6 copies of each request for substitution for consideration. Submit requests in the form and in accordance with procedures required for Change Order proposals.

C. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:

1. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
2. Samples, where applicable or requested.
3. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
4. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
5. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
6. Cost information, including a proposal of the net change, if any in the Contract Sum.
7. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.

D. Engineer's Action: Within 10 days of receipt of the request for substitution, the Engineer will request additional information or documentation necessary for evaluation of the request. Within 14 days of receipt of the request, or 14 days of receipt of the additional information or documentation, which ever is later, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance will be in the form of a Change Order.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

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

1. Extensive revisions to Contract Documents are not required.
2. Proposed changes are in keeping with the general intent of Contract Documents.
3. The request is timely, fully documented and properly submitted.
4. The request is directly related to an "or equal" clause or similar language in the Contract Documents.
5. The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
6. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
7. A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.
8. The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where the Contractor certifies that the substitution will overcome the incompatibility.
9. The specified product or method of construction cannot be coordinated with other materials, and where the Contractor certifies that the proposed substitution can be coordinated.
10. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provide the required warranty.

The Contractor's submittal and Engineer's acceptance of Shop Drawings, Product Data or Samples that relate to construction activities not complying with the Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 012500

SECTION 012600 - MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.

1.3 MINOR CHANGES IN THE WORK

A. The Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract Time, on AIA Form G710, Architect's Supplemental Instructions.

1.4 CHANGE ORDER PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: The Engineer will issue a detailed description of proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

B. Proposal requests issued by the Engineer are for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.

C. Within 10 days of receipt of a proposal request, submit an estimate of cost necessary to execute the change to the Engineer for the Owner's review.

1. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
2. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
3. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.

D. Contractor-Initiated Proposals: When latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Engineer.

1. Include a statement outlining the reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and Contract Time.
2. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Comply with requirements in Section 012500, "Product Substitutions" if the proposed change requires substitution of one product or system for a product or system specified.

E. Proposal Request Form: Use AIA Document G709 for Change Order Proposal Requests.

1.5 CONSTRUCTION CHANGE DIRECTIVE

A. When the Owner and the Contractor disagree on the terms of a Proposal Request, the Engineer may issue a Construction Change Directive on AIA Form G714. The Construction Change Directive instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

B. The Construction Change Directive contains a complete description of the change in the Work. It also designates the method to be followed to determine change in the Contract Sum or Contract Time.

C. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

D. After completion of the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

1.6 CHANGE ORDER PROCEDURES

A. Upon the Owner's approval of a Proposal Request, the Engineer will issue a Change Order for signatures of the Owner and the Contractor on AIA Form G701.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 012600

SECTION 013100 - PROJECT COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and supervisory requirements necessary for Project coordination including, but not necessarily limited to:

1. Coordination
2. Administrative and supervisory personnel
3. General installation provisions
4. Cleaning and protection

B. Progress meetings, coordination meetings and pre-installation conferences are included in Section 013119, "Project Meetings".

C. Requirements for the Contractor's Construction Schedule are included in Section 013300, "Submittals".

1.3 COORDINATION

A. Coordinate construction activities included under various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections of the Specifications that are dependent upon each other for proper installation, connection, and operation.

1. Where installation of one part of the Work is dependent on installation of other components, either before or after its own installation, schedule construction activities in the sequence required to obtain the best results.
2. Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Where necessary, prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.

1. Prepare similar memoranda for the Owner and separate Contractors where coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of schedules
2. Installation and removal of temporary facilities
3. Delivery and processing of submittals
4. Progress meetings
5. Project Close-out activities

1.4 SUBMITTALS

A. Staff Names: Within 15 days of Notice to Proceed, submit a list of the Contractor's principal staff assignments, including the Superintendent and other personnel in attendance at the site; identify individuals, their duties and responsibilities; list their addresses and telephone numbers.

B. Post copies of the list in the temporary field office.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION PROVISIONS

A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.

B. Manufacturer's Instructions: Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in Contract Documents.

C. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged and defective items.

D. Provide attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion and building movement.

E. Visual Effects: Provide uniform joint widths in exposed Work. Arrange joints in exposed Work to obtain the best visual effect. Refer questionable choices to the Engineer for final decision.

F. Recheck measurements and dimensions, before starting each installation.

G. Install each component during weather conditions and Project status that will ensure the best possible results. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration.

H. Coordinate temporary enclosures with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.

I. Mounting Heights: Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decisions to the Engineer for final decision.

3.2 CLEANING AND PROTECTION

A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

B. Clean and maintain completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

C. Limiting Exposures: Supervise construction activities to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:

1. Excessive static or dynamic loading
2. Excessive internal or external pressures
3. Excessively high or low temperatures
4. Thermal shock
5. Excessively high or low humidity
6. Air contamination or pollution
7. Water or ice
8. Solvents
9. Chemicals
10. Light
11. Radiation
12. Puncture
13. Abrasion
14. Heavy traffic
15. Soiling, staining and corrosion

16. Bacteria
17. Rodent and insect infestation
18. Combustion
19. Electrical current
20. High speed operation
21. Improper lubrication
22. Unusual wear or other misuse
23. Contact between incompatible materials
24. Destructive testing
25. Misalignment
26. Excessive weathering
27. Unprotected storage
28. Improper shipping or handling
29. Theft
30. Vandalism

END OF SECTION 013100

SECTION 013119 - PROJECT MEETINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division-1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for project meetings including but not limited to:

1. Pre-Construction Conference
2. Progress Meetings

B. Construction schedules are specified in another Division-1 Section.

1.3 PRE-CONSTRUCTION CONFERENCE

A. Schedule a pre-construction conference and organizational meeting at the Project site or other convenient location no later than 15 days after execution of the Agreement and prior to commencement of construction activities. Conduct the meeting to review responsibilities and personnel assignments.

B. Attendees: The Owner, Engineer and their consultants, the Contractor and its superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matters relating to the Work.

C. Agenda: Discuss items of significance that could affect progress, including such topics as:

1. Tentative construction schedule
2. Critical Work sequencing
3. Designation of responsible personnel
4. Procedures for processing field decisions and Change Orders
5. Procedures for processing Applications for Payment
6. Distribution of Contract Documents
7. Submittal of Shop Drawings, Product Data and Samples
8. Preparation of record documents
9. Use of the premises
10. Office, Work and storage areas
11. Equipment deliveries and priorities

12. Safety procedures
13. First aid
14. Security
15. Housekeeping
16. Working hours

D. Reporting: No later than 7 days after the pre-construction conference date, the Engineer will distribute copies of minutes of the conference to each party present and to other parties concerned who were not present. Included will be summaries, in narrative form, of all discussions, agreements, decisions and matters concluded.

1.4 PROGRESS MEETINGS

A. Conduct progress meetings at the Project site at regularly scheduled weekly intervals. Coordinate dates of alternate meetings with preparation of the payment request. The Engineer or the Owner’s Construction Project Manager will chair the meeting.

B. Attendees: In addition to representatives of Owner and Engineer, each subcontractor, supplier or other entity concerned with current progress or involved in planning, coordination or performance of future activities shall be represented at these meetings by persons familiar with the Project and authorized to conclude matters relating to progress.

C. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the current status of the Project, and topics required by the General Conditions.

D. Contractor's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time or ahead or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

E. Review the present and future needs of each entity present, including such items as:

1. Interface requirements
2. Time
3. Sequences
4. Deliveries
5. Off-site fabrication problems
6. Access
7. Site utilization
8. Temporary facilities and services
9. Hours of Work
10. Hazards and risks
11. Housekeeping
12. Quality and Work standards
13. Change Orders

14. Documentation of information for payment requests

F. Reporting: No later than 3 days after each progress meeting date the Engineer will distribute copies of minutes of the meeting to each party present and to other parties who should have been present. The Contractor shall provide a brief summary, in narrative form, of progress since the previous meeting and report, to be attached to the minutes.

G. Schedule Updating: Revise the construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue the revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 PRECONSTRUCTION CONFERENCE FORMAT

A. The format of the Agenda for the Preconstruction Conference shall generally be as follows:

PRE-CONSTRUCTION CONFERENCE FORMAT

PRE-CONSTRUCTION CONFERENCE FOR:

OWNER: _____
PROJECT: _____
LOCATION: _____
COMM. NO.: _____TIME:_____DATE:_____

AGENDA AND MINUTES

1. GENERAL

   a. Introductions and Registrations of Attendees (sign attached sheet)
   b. Conference Format and Agenda
   c. Agreement, Performance and Payment Bonds and Insurance
   d. Notice to Proceed
   e. Responsibilities of Owner, Contractor, Engineer, and Inspector

2. PROJECT COMMUNICATION AND CORRESPONDENCE

   a. With Contractor:

      Field Superintendent will be: _____
      Company_____
      Street:_____
      P. O. Box: (if any)_____
      City & Zip:_____
      Attention:_____

	OFFICE	FIELD	CELL
Telephone:	_____	_____	_____

   b. With Engineer:

      Project Engineer will be: _____
      Company:_____
      Street:_____
      P. O. Box: (if any) _____
      City & Zip:_____
      Attention:_____

	OFFICE	FIELD	CELL
Telephone:	_____	_____	_____

      1) For questions, information, etc., Attention:_____

In the absence of Mr. _____, if necessary, contact first _____,
and second_____.

2) For shop drawings and other submittals, use:
_____

3) Discuss submittals and other points on shop drawings, samples, test data, brochures and other submittals.

c. With Owner – Inspector will be_____.
Project Manager: _____.

1) Copies of correspondence
2) Through Inspector and Engineer
3) Project Identification

d. With material suppliers and subcontractors
e. Other

3. SCHEDULE, ESTIMATES, CHANGE ORDERS AND TIME EXTENSIONS

a. Project Schedule: CPM, bar chart, other
b. Schedule of Values (Lump Sum Breakdown)

c. Monthly requests for payment

1) Closing date
2) Format
3) Preliminary approval by Inspector and Engineer copy to Owner
4) Work done and materials on hand
5) Place and projection of materials on hand
6) Conformance to schedule

d. List of subcontractors and major suppliers

e. Change Orders

1) Request for Proposal and Response
2) Acceptance by Engineer and Owner
3) Change Order execution by Contractor, Engineer, and Owner
4) Time extension, if any
5) Not official until approved by Contractor and Owner

f. Time extensions (other than Change Orders) all are to be on change order request.

4. CONSTRUCTION

a. Manner of conducting the work

b. Construction plant area

1) On-site
2) Off-site
3) Disposal of wastes

c. Project sign(s)
d. Temporary facilities
e. Traffic maintenance
f. Safety – Public, on-site, personnel

g. Contractor's Quality Plan and Owner's Quality Assurance Plan

1) Certificates – mfg.
2) Construction quality

5. PROJECT CLOSEOUT

a. Final cleanup
b. Guarantees

c. Punch lists and final inspections

1) Testing and Adjusting
2) O & M instructions and manuals

d. Final payment, Affidavits for Payments of Debts and Claims, Consent of Surety, Release or Waiver of Liens
e. Record drawings
f. Assessment of Roles in Construction Project
g. Other

6. ADDED COMMENTS BY OWNER

7. ADDED COMMENTS BY CONTRACTOR

8. ADDED COMMENTS BY PRINCIPAL SUBCONTRACTORS

END OF SECTION 013119

SECTION 013300 - SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for submittals required for performance of the Work, including:

1. Contractor's Construction Schedule
2. Submittal Schedule
3. Daily Construction Reports
4. Shop Drawings
5. Product Data
6. Samples
7. Quality Assurance Submittals

B. Administrative Submittals: Refer to other Division-1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to:

1. Permits
2. Applications for Payment
3. Performance and Payment Bonds
4. Insurance Certificates
5. List of Subcontractors

1.3 SUBMITTAL PROCEDURES

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

B. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.

C. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.

1. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
2. All samples, shop drawings, and product data for finish materials requiring color selection or verification by the Engineer shall be submitted as follows: All exterior finish materials shall be submitted at one time and the Engineer will take no action on any one submittal until all items have been submitted. All interior finish materials shall also be submitted at one time, and the Engineer will take no action on any one submittal until all items have been submitted.

D. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for re-submittals.

1. Allow 14 days for initial review. Allow additional time, if processing must be delayed, to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
2. If an intermediate submittal is necessary, process the same as the initial submittal.
3. Allow 14 days for reprocessing each submittal.
4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

E. General Contractor's Review: All submittals shall be reviewed and approved by the General Contractor for conformance to the Contract Requirements and coordination with the work of other trades prior to submission to the Engineer. All submittals submitted without the General Contractor's stamp of approval will not be considered or reviewed by the Engineer and will be returned to the General Contractor.

F. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

1. Provide a space approximately 4" x 5" on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.

2. Include the following information on the label for processing and recording action taken.

   a. Project name
   b. Date
   c. Transmittal Number
   d. Transmittal Item Number
   e. Name and address of Engineer
   f. Name and address of Contractor
   g. Name and address of subcontractor
   h. Name and address of supplier
   i. Name of manufacturer
   j. Number and title of appropriate Specification Section
   k. Drawing number and detail references, as appropriate

G. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action.

1. On the transmittal record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

H. Completion of transmittal form by the Contractor shall be as follows:

1. Transmittal Number: Number each form consecutively as submitted. Re-submittals shall bear the number of the original submission with a letter suffix (A) added to identify it as the first resubmission. The suffix letters (B), (C), etc. shall be used if additional resubmissions are necessary.
2. Date all transmittals.
3. Restrict use of each transmittal form to submittals for one section of Specifications per form.

4. Restrict each transmittal form to a submission in only one of the following categories:

   a. For approval
   b. Resubmission for approval
   c. Substitution for approval

5. Item Number: Number consecutively each item submitted with each transmittal form.
6. Specification section and/or drawing number which describes or requires the item(s) shall be included for each item submitted.
7. Subcontractor: Indicate the Subcontractor for items submitted on each transmittal form.
8. Contractor, or his authorized representative shall sign each transmittal form.

I. Transmittal Form: Use the sample form at the end of this Section for transmittal of submittals.

1.4 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Critical Path Method (CPM) Bar Chart Type Schedule: Prepare a fully developed, critical path method horizontal bar-chart type Contractor's Construction Schedule. Submit within 15 days of the date established for "Commencement of the Work".

1. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated in the "Schedule of Values".
2. Within each time bar indicate estimated completion percentage in 10 percent increments. As Work progresses, place a contrasting mark in each bar to indicate Actual Completion.
3. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for the entire construction period.

4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on the schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the Work.
5. Coordinate the Contractor's construction schedule with the Schedule of Values, list of subcontracts, submittal schedule, progress reports, payment requests and other schedules.
6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on the schedule to allow time for the Engineer's procedures necessary for certification of Substantial Completion.

B. Distribution: Following response to the initial submittal, print and distribute copies to the Engineer, Owner, subcontractors, and other parties required to comply with scheduled dates. Post copies in the Project temporary field office.

1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

C. Schedule Updating: Revise the schedule after each meeting or activity, where revisions have been recognized or made. Issue the updated schedule concurrently with report of each meeting.

1.5 SUBMITTAL SCHEDULE

A. After development and acceptance of the Contractor's Construction Schedule, prepare a complete schedule of submittals. Submit the schedule within 10 days of the date required for establishment of the Contractor's construction schedule.

B. Coordinate submittal schedule with the list of subcontracts, schedule of values and the list of products as well as the Contractor's construction schedule.

C. Prepare the schedule in chronological order; include submittals required during the first 30 days of construction. Provide the following information:

1. Scheduled date for the first submittal
2. Related Section number
3. Submittal category
4. Name of subcontractor
5. Description of the part of the Work covered
6. Scheduled date for re-submittal
7. Scheduled date the Engineer's final release or approval

D. Distribution: Following response to initial submittal, print and distribute copies to the Engineer, Owner, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the Project and field office.

1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

E. Schedule Updating: Revise the schedule after each meeting or activity, where revisions have been recognized or made. Issue the updated schedule concurrently with report of each meeting.

1.6 DAILY CONSTRUCTION REPORTS

A. Prepare a daily construction report, recording the following information concerning events at the site; and submit copies to the Engineer and Owner at weekly intervals:

1. List of subcontractors at the site
2. Approximate count of personnel at the site
3. High and low temperatures, general weather conditions
4. Accidents and unusual events
5. Include measured amount of precipitation at project site, occurring daily during period since previous report
6. Meetings and significant decisions
7. Stoppages, delays, shortages, losses
8. Meter readings and similar recordings
9. Emergency procedures
10. Orders and requests of governing authorities
11. Change Orders received, implemented
12. Services connected, disconnected
13. Equipment or system tests and start-ups
14. Partial Completions, occupancies
15. Substantial Completions authorized

1.7 SHOP DRAWINGS

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

B. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Include the following information:

1. Dimensions
2. Identification of products and materials included
3. Compliance with specified standards
4. Notation of coordination requirements
5. Notation of dimensions established by field measurement

C. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2" x 11" but no larger than 30" x 40".

D. Submittals: Submit sufficient number of shop drawings as determined by the Contractor. The Engineer shall retain one copy for his use and two copies for the Owner’s use.

E. Distribution: Furnish copies of final submittal to the installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.

F. Do not proceed with installation until a copy of applicable Shop Drawings is in the installer's possession.

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

H. Engineer will make distribution to the Owner.

1.8 PRODUCT DATA

A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves. Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as "Shop Drawings."

B. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information:

1. Manufacturer's printed recommendations
2. Compliance with recognized trade association standards
3. Compliance with recognized testing agency standards
4. Application of testing agency labels and seals
5. Notation of dimensions verified by field measurement
6. Notation of coordination requirements
7. Material Safety Data Sheets (MSDS)

C. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

D. Submittals: Submit sufficient number of required submittals as determined by the Contractor. The Engineer shall retain one copy for his use and two copies for the Owner’s use.

1. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.

E. Distribution: Furnish copies of final submittal to the installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.

F. Do not proceed with installation until an applicable copy of Product Data applicable is in the installer's possession.

G. Do not permit use of unmarked copies of Product Data in connection with construction.

H. Engineer will make distribution to the Owner.

1.9 SAMPLES

A. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture and pattern.

1. Mount, display, or package Samples in the manner specified to facilitate review of qualities indicated. Prepare Samples to match the Engineer's Sample. Include the following:

    a. Generic description of the Sample
    b. Sample source
    c. Product name or name of manufacturer
    d. Compliance with recognized standards
    e. Availability and delivery time

2. Submit Samples for review of kind, color, pattern, and texture, for a final check of these characteristics with other elements, and for a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
3. Where variation in color, pattern, texture or other characteristics are inherent in the material or product represented, submit multiple units (not less than 3), that show approximate limits of the variations.
4. Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation and similar construction characteristics.
5. Refer to other Sections for Samples to be returned to the Contractor for incorporation in the Work. Such Samples must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of Sample submittals.

B. Preliminary submittals: Where Samples are for selection of color, pattern, texture or similar characteristics from a range of standard choices, submit a full set of choices for the material or product.

1. Preliminary submittals will be reviewed and returned with the Engineer's mark indicating selection and other action.

C. Submittals: Except for Samples illustrating assembly details, workmanship, fabrication techniques, connections, operation and similar characteristics, submit four sets; one will be returned marked with the action taken.

D. Maintain sets of Samples, as returned, at the Project site, for quality comparisons throughout the course of construction.

1. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
2. Sample sets may be used to obtain final acceptance of the construction associated with each set.

E. Distribution of Samples: Prepare and distribute additional sets to subcontractors, manufacturers, fabricators, suppliers, installers, and others as required for performance of the Work. Show distribution on transmittal forms.

F. Field Samples specified in individual Sections are special types of Samples. Field Samples are full-size examples erected on site to illustrate finishes, coatings, or finish materials and to establish the standard by which the Work will be judged.

G. Comply with submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity.

H. Engineer will make distribution to the Owner.

1.10 QUALITY ASSURANCE SUBMITTALS

A. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.

B. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.

1. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.

C. Inspection and Test Reports: Requirements for submittal of inspection and test reports from independent testing agencies are specified in Division 1 Section "Quality Control."

1.11 ENGINEER'S ACTION

A. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer will review each submittal, mark to indicate action taken, and return promptly.

B. Compliance with specified characteristics is the Contractor's responsibility.

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

D. Final Unrestricted Release: Where submittals are “FURNISH AS SUBMITTED," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.

E. Final-But-Restricted Release: When submittals are marked "FURNISH AS CORRECTED," that part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.

F. Final-But-Restricted Release Requiring Resubmission: When submittals are marked "REVISE AND RESUBMIT," that part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance. Revise or prepare new submittal in accordance with the notations; resubmit without delay.

G. Returned for Re-submittal: When submittal is marked "REJECTED," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.

1. Do not permit submittals marked "REJECTED" to be used at the Project site, or elsewhere where Work is in progress.

H. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "RECEIPT ACKNOWLEDGED".

I. Unsolicited Submittals: The Engineer will return unsolicited submittals to the sender without action.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 013300

SECTION 014219 - REFERENCE STANDARDS AND DEFINITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the General Conditions.

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

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

D. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.

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

F. Furnish: The term "furnish" means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

H. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

I. Installer: An "Installer" is the Contractor or an entity engaged by the Contractor, either as an employee, subcontractor, or sub-subcontractor, for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

J. The term "experienced" when used with the term "Installer" means having a minimum of five (5) previous Projects similar in size and scope to this Project, being familiar with the precautions required, and having complied with requirements of the authority having jurisdiction.

K. Trades: Use of titles such as "carpentry" is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.

L. Assignment of Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.

1. This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

M. Project Site is the space available to the Contractor for performance of construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project Site is shown on the Drawings and may or may not be identical with the description of the land upon which the Project is to be built.

N. Testing Laboratories: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.3 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specification Format: These Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's 16-Division format and MASTERFORMAT numbering system.

B. Specification Content: This Specification uses certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

C. Abbreviated Language: Language used in Specifications and other Contract Documents is the abbreviated type. Implied words and meanings will be appropriately interpreted. Singular words will be interpreted as plural and plural words interpreted as singular where applicable and the full context of the Contract Documents so indicates.

D. Imperative and streamlined language is used generally in the Specifications. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in

the text, for clarity, subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.

1. The words "shall be" shall be included by inference wherever a colon (:) is used within a sentence or phrase.

1.4 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Where the date of issue of a referenced standard is not specified, comply with the standard in effect as of date of Contract Documents.

C. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards establish different or conflicting requirements for minimum quantities or quality levels, refer requirements that are different, but apparently equal, and uncertainties to the Engineer for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum, as appropriate for the context of the requirements. Refer uncertainties to the Engineer for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed for performance of a required construction activity, the Contractor shall obtain copies directly from the publication source.

E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.

1.5 GOVERNING REGULATIONS/AUTHORITIES

A. The Engineer has contacted authorities having jurisdiction where necessary to obtain information necessary for preparation of Contract Documents; that information may or may not

be of significance to the Contractor. Contact authorities having jurisdiction directly for information and decisions having a bearing on the Work.

1.6 SUBMITTALS

A. Permits, Licenses, and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 014219

SECTION 015000 - TEMPORARY FACILITIES AND PROTECTION OF PROPERTY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies requirements for temporary services and facilities, including utilities, construction and support facilities, security and protection of property.

B. Temporary utilities required include but are not limited to:

1. Use of electric power and water.
2. Provision of telephone and fax.
3. Sanitary facilities, including drinking water.

C. Temporary construction and support facilities required include but are not limited to:

1. Temporary job office.
2. Waste disposal services.
3. Construction aids and miscellaneous services and facilities.

D. Security and protection facilities required include but are not limited to:

1. Staging and storage areas.
2. Temporary fire protection.
3. Barricades, warning signs, lights.
4. Protection of installed work.
5. Security against theft and vandalism.

1.3 SUBMITTALS

A. Drawings: Submit partial site plans that indicate the following:

1. Proposed locations of fenced temporary storage areas for material and equipment.
2. Dimensions of fenced storage locations indicating gates.
3. Location of job office.
4. Contractor parking area.
5. Proposed crane access for setting of roof mounted equipment.

1.4 QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:

1. Building Code requirements.
2. Health and safety regulations.
3. Utility company regulations.
4. Police, Fire Department and Rescue Squad rules.
5. Environmental protection regulations.

B. Standards: Comply with NFPA Code 241, "Building Construction and Demolition Operations", ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition".

1.5 PROJECT CONDITIONS

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

B. Maintain security against theft and vandalism for the site and the building at all times until the date of Substantial Completion.

1.6 DESCRIPTION OF REQUIREMENTS

A. Definitions: Specific administrative and procedure minimum actions are specified in this section, as extensions of provisions in General Conditions and other contract documents. These requirements have been included for special purposes as indicated. Nothing in this section is intended to limit types and amount of temporary work required, and no omission from this section will be recognized as an indication by the Engineer that such temporary activity is not required for successful completion of the work and compliance with requirements of contract documents. Provisions of this section are applicable to, but not limited to utility services, construction facilities, security/protection provisions and support facilities.

B. It shall be the responsibility of the Contractor to determine the applicable requirements to initiate and maintain all required safety and health programs, and to follow the recommendations of Federal, State and Local officials.

1.7 JOB OFFICE

A. Provide job office for the resident superintendent and his assistants to be located in an Owner approved location. Maintain during the entire construction period. Maintain construction and record documents at the job office. Include the following as a minimum in the office:

1. Work table, minimum size 36" x 72".
2. Telephone and fax machine.
3. Air conditioning, ventilation, and lighting.

1.8 TEMPORARY ELECTRIC POWER AND WATER

A. The contractor may utilize existing permanent electric power and water within the facility during the construction phase of the work. Coordinate connection requirements with Owner's representative. All connection costs shall be borne by the Contractor. Usage costs shall be borne by the Owner. Contractor's use of Owner's existing permanent power and water shall in no way limit availability of these utilities to the Owner's facilities. Contractor shall restore Owner's permanent utilities to pre-construction conditions after removal of temporary utility connections.

1.9 TEMPORARY TELEPHONE AND FAX

A. Provide a job telephone and fax machine through the completion of all punch list items until Substantial Completion and Owner occupancy.

B. Pay for installation, maintenance, removal, and local service charges.

C. Long-distance calls shall be paid by the party who places the call.

1.10 SANITARY FACILITIES

A. Existing toilet facilities as designated by the Owner may be used by construction personnel. Toilets shall be cleaned by the Contractor on a daily basis. Should the Contractor fail to keep toilet facilities clean and in good working order as determined by the Owner, the use of the existing toilet facilities by construction personnel shall be terminated. Should use of the existing toilet facilities be terminated by the Owner, the Contractor shall provide temporary toilet facilities, wash stations, and drinking fountains located outside of the school located as directed by Owner.

B. Provide sanitary facilities for the duration of the project including the punch list period.

1.11 SIGNS

A. A project sign may be provided in accordance with the Owner's standards.

1.12 FIRE PROTECTION

A. Provide temporary fire protection as required by authorities having jurisdiction throughout the entire construction period. Maintain access to the site and to the building at all times for Fire Department apparatus and personnel. Maintain access to fire protection devices at all times.

1.13 STAGING AND STORAGE AREAS

A. Locate staging and storage areas within areas designated or approved by the Owner. Provide gates, double gates, fencing and locks as required to secure all construction materials and protect from vandalism. Remove any potentially hazardous or flammable materials, including all welding materials, from the site at the end of each workday. Materials which will be installed in the project area shall not be stored in uncontrolled exterior locations where they may be susceptible to temperature, humidity, rain, dirt, and dust.

B. Provide and maintain weathertight storage as required.

1.14 PROTECTION OF INSTALLED WORK

A. Protect installed work from elevated temperature and humidity, dust, and dirt. Provide special protection where specified in individual Specification Sections.

B. Provide protective coverings at openings in air-handling units, ductwork, chases, walls, and other items of construction to prevent damage, contamination by dust, and transmission of dust to other spaces.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to minimize damage.

D. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

E. Use all means necessary to protect the site, the building, and all materials stored or installed at all times, including the employment of a watchman or guard when required.

F. Provide weather protection as described in this specification for any penetrations made in the existing building.

G. Where mechanical and other construction work is performed from the roof, the immediate area or as indicated shall be protected with plywood, particle board, or other approved protection board. Where construction workers are likely to walk, protect similarly. Protection shall be secured in an approved manner to prevent damage to roof. Remove protection board from the site upon completion of the work.

1.15 REMOVAL

A. Remove all temporary facilities from the site and leave the site and affected off-site areas in a clean and finished condition prior to final acceptance.

1.16 OSHA (Occupational Safety and Health Act)

A. Comply with all requirements of the Occupational Safety and Health Act for job safety and health standards.

1.17 CONSTRUCTION AIDS

A. Provide all temporary stairs, ladders, ramps, runways, hoists, chutes, and other facilities necessary for the proper execution of the work. Provide guard rails and warning lights as required for job safety.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials suitable for the use intended.

2.2 EQUIPMENT

A. General: Provide equipment suitable for use intended.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.

B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

C. Temporary Lighting: Whenever overhead floor or roof deck has been installed, provide temporary lighting with local switching.

D. Install and operate temporary lighting that will fulfill security and protection requirements, without operating the entire system, and will provide adequate illumination for construction operations and traffic conditions.

E. Telephones: Provide cellular telephone service for all personnel engaged in construction activities, throughout the construction period, until final completion.

F. Existing sanitary facilities may be used by construction personnel under the conditions specified herein and as designated by the Owner. iComply with regulations and health codes for t operation and maintenance of existing fixtures and facilities.

G. Provide toilet tissue, paper towels, paper cups and similar disposable materials for existing facility designated by the Owner to be used by construction personnel. Provide covered waste containers for used material.

H. Wash Facilities: Supply cleaning compounds appropriate for each condition.

3.2 TEMPORARY CONSTRUCTION AND SUPPORT FACILITIES INSTALLATION

A. Maintain temporary construction and support facilities until near Substantial Completion. Remove prior to Substantial Completion, unless otherwise indicated. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.

B. Temporary Enclosures: Provide temporary enclosure for protection of construction in progress and completed, from exposure, foul weather, other construction operations and similar activities.

C. Install tarpaulins securely, with incombustible wood framing and other materials. Close openings of 25 square feet or less with plywood or similar materials.

D. Close openings through floor or roof decks and horizontal surfaces with load-bearing wood-framed construction.

E. Temporary Lifts and Hoists: Provide facilities for hoisting materials and employees. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

F. Project Identification and Temporary Signs: Signs are not permitted.

G. Collection and Disposal of Debris and Waste: Collect debris and waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 deg F (27 deg C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.

H. Burying of waste materials on the site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

I. Provide rodent proof containers located convenient to areas of construction.

J. Provide a dumpster for use by all subcontractors.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer as requested by the Engineer.

B. Temporary Fire Protection: Until fire protection needs are supplied by permanent facilities, install and maintain temporary fire protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers," and NFPA 241 "Standard for Safeguarding Construction, Alterations and Demolition Operations."

1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near each usable stairwell.
2. Store combustible materials in containers in fire-safe locations.
3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways and other access routes for fighting fires. Prohibit smoking in hazardous fire exposure areas.

C. Provide supervision of welding operations, combustion type temporary heating units, and similar sources of fire ignition.

D. Barricades, Warning Signs and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed provide lighting, including flashing red or amber lights.

E. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft and similar violations of security.

F. Storage: Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.

G. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

3.4 OPERATION, TERMINATION AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation and similar facilities on a 24-hour day basis where required to achieve indicated results and to avoid possibility of damage.
2. Protection: Prevent water filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Termination and Removal: Unless the Engineer requests that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired.

D. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

E. Repair or replace street paving, curbs and sidewalks damaged by construction activities to match surrounding conditions.

F. Seed the staging and storage areas within construction fences and any other areas on the school property where damage has occurred due to trucks, cranes, excavations, or other construction activities.

G. A satisfactory stand of turf from the seeding operation is defined as a minimum of 15 grass plants per square foot. Bare spots can be no larger than 6" square. Total bare spots must be less than 2% of the total seeded area.

H. Contractor is responsible for maintenance of seeded area until acceptance by Owner.

END OF SECTION 015000

SECTION 017000 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for project closeout, including but not limited to:

1. Punch List procedures.
2. Project record document submittal.
3. Operating and maintenance manual submittal.
4. Submittal of warranties.
5. Final cleaning.

B. Closeout requirements for specific construction activities are included in the appropriate Sections in Divisions 1 through 16.

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting punch list for certification of Substantial Completion, complete the following. List exceptions in the request.

1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100% completion for the portion of the Work claimed as substantially complete. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.

    a. If 100% completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.

2. Advise Owner of pending insurance change-over requirements.
3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.
4. Obtain and submit releases enabling the Owner unrestricted use of the Work and access to services and utilities; include occupancy permits, operating certificates and similar releases.

5. Submit record drawings, operations and maintenance manuals, and similar final record information. Operations and maintenance manuals shall be furnished to Owner 14 days before date operation and maintenance instructions and demonstrations are to occur.
6. Deliver tools, spare parts, extra stock, and similar items.
7. Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
8. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel.
9. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
10. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

B. Contractor's Punch List Report: Prepare a complete list of all work remaining to be completed, deficiencies to be corrected, and any other items or requirements not yet fulfilled.

C. Punch List Procedures: On receipt of a request for Punch List and the Contractor's Punch List Report, the Engineer will either proceed with Punch List or advise the Contractor of unfulfilled requirements. The Engineer will prepare the Certificate of Substantial Completion following Punch List or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.

D. The Engineer will repeat Punch List when requested and assured that the Work has been substantially completed.

E. Results of the completed Punch List will form the basis of requirements for final acceptance.

1.4 FINAL ACCEPTANCE

A. Preliminary Procedures: Before requesting final Punch List for certification of final acceptance and final payment, complete the following. List exceptions in the request.

1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
3. Submit a certified copy of the Engineer's final Punch List of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance and the list has been endorsed and dated by the Engineer.
4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion, or when the Owner took possession of and responsibility for corresponding elements of the Work.
5. Submit Consent of Surety to Final Payment.
6. Submit a final liquidated damages settlement statement.
7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

8. See Project Closeout Checklist at the end of this Section for additional requirements.

B. Punch List Backcheck Procedure: The Engineer will backcheck the Work upon receipt of notice that the Work, including Punch List items from earlier Punch Lists, has been completed, except items whose completion has been delayed because of circumstances acceptable to the Engineer.

1. Upon completion of backcheck, the Engineer will prepare a certificate of final acceptance or advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
2. Only if absolutely necessary, will the Punch List backcheck procedure be repeated. It is the Contractor's responsibility to inspect the Work and have all items completed prior to requesting a Punch List backcheck. All Engineer's costs incurred beyond the initial Punch List backcheck shall be borne by the Contractor.

1.5 RECORD DOCUMENT SUBMITTALS

A. General: Refer to Section 017839, “Project Record Documents”, for additional requirements. Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Maintenance Manuals: Refer to Section 017823, “Operation and Maintenance Data” for submittal requirements.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 CLOSEOUT PROCEDURES

A. Operating and Maintenance Instructions: Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Two weeks prior to all demonstrations, such as the mechanical and electrical controls and equipment, plumbing, and, fire alarm, the Owner shall have in his possession all related manuals of operation and maintenance for the system. The Owner shall be notified one week in advance of intended time and date of all above demonstrations. Include a detailed review of the following items:

1. Maintenance manuals.
2. Record documents.
3. Spare parts and materials.
4. Tools.

5. Lubricants.
6. Fuels.
7. Identification systems.
8. Control sequences.
9. Hazards.
10. Cleaning.
11. Warranties and bonds.
12. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:

1. Start-up.
2. Shutdown.
3. Emergency operations.
4. Noise and vibration adjustments.
5. Safety procedures.
6. Economy and efficiency adjustments.
7. Effective energy utilization.
8. Trouble-shooting procedures and corrections (explain most frequent causes of failure).

P R O J E C T C L O S E O U T C H E C K L I S T

The following items must be submitted prior to processing Final Application and Certificate for Payment and Closeout of Project.

ITEM	STATUS
Certificate of Substantial Completion	Engineer will provide
Letter from Contractor indicating that items on the Punch List have been completed, corrected and accepted by the Engineer	
Consent of the Surety Company to final payment	
General Release from Contractor	
Release of Liens from Major Subcontractors	
Affidavit of the Contractor that all Subcontractors and material men have been paid in full	
Written certification from the Contractor to the Engineer and Owner that no asbestos containing materials or products were included in the Project	
Record Drawings	
Record Specifications	
Operations and Maintenance Manuals	
Standard Warranty from Contractor	
Special Warranties from Materials & Equipment Suppliers	
Cost proposals for all outstanding changes in the Contract	
Final Application and Certificate for Payment	

END OF SECTION 017000

SECTION 017400 - FINAL CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division-1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for final cleaning at Substantial Completion.

B. Special cleaning requirements for specific elements of the Work area included in appropriate Sections of Divisions 1 through 16.

C. General Project closeout requirements are included in Section 017000, "Project Closeout".

D. General cleanup and waste removal requirements are included in Section 015000, "Temporary Facilities".

E. Environmental Requirements: Conduct cleaning and waste disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and anti-pollution regulations.

1. Do not dispose of volatile wastes such as mineral spirits, oil or paint thinner in storm or sanitary drains.
2. Burying of debris, rubbish or other waste material on the premises will not be permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by the manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property, or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Provide final cleaning operations when indicated. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of Work to the condition expected from a commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

B. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion for the entire Project or a portion of the Project.

C. Clean the Project site, yard and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste materials, litter and foreign substances. Sweep paved areas broom clean. Remove petro-chemical spills, stains and other foreign deposits. Rake grounds that are neither planted nor paved, to a smooth even-textured surface.

D. Remove tools, construction equipment, machinery and surplus material from the site.

E. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

F. Remove debris and surface dust from limited access spaces, including roofs, plenums, and similar spaces.

G. Remove labels that are not permanent labels.

H. Touch-up and otherwise repair and restore marred exposed finishes and surfaces. Replace finishes and surfaces that can not be satisfactorily repaired or restored, or that show evidence of repair or restoration. Do not paint over "UL" and similar labels, including mechanical and electrical name plates.

I. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication, paint and mortar droppings and other foreign substances.

J. Leave the Project clean and ready for occupancy.

K. Removal of Temporary Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.

L. Compliances: Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from the site and dispose of in a lawful manner.

M. Where extra materials of value remain after completion of associated construction have become the Owner's property, dispose of these materials as directed.

END OF SECTION 017400

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

A. Work Included: To aid the continued instruction of operating and maintenance personnel, and to provide a positive source of information regarding the products incorporated into the work, furnish and deliver the data described in this section and in pertinent other sections of these Specifications.

B. Related Work: Required contents of submittals also may be amplified in pertinent other sections of these Specifications.

1.3 QUALITY ASSURANCE

A. In preparing data required by this Section, use only personnel who are thoroughly trained and experienced in the operation and maintenance of the described items, completely familiar with the requirements of this Section, and skilled in communicating the essential data.

1.4 SUBMITTALS

A. Unless otherwise directed in other sections or in writing by the Engineer, submit three copies of the final manual to the Engineer for approval prior to indoctrination of operation and maintenance personnel.

PART 2 - PRODUCTS

2.1 INSTRUCTION MANUALS

A. Where instruction manuals are required to be submitted under other Sections of these Specifications, prepare in accordance with the provisions of this Section.

B. Format:

1. Size: 8-1/2" x11"
2. Paper: White bond, at least 20 lb weight.
3. Text: Typed (Hand printed or written is not acceptable)
4. Drawings: 11" x 8" preferable; bind in with text; foldouts are acceptable; larger drawings are acceptable if folded to fit within the manual and provide a drawing pocket inside rear cover or bind in with text.
5. Fly Sheets: Separate each portion of the manual with neatly prepared Fly Sheets or tabbed index sheets briefly describing the contents of the ensuing portion. Fly Sheets or index tabs may be in color.
6. Binding: Use heavy-duty plastic covers with binding mechanism concealed inside the manual; 3-ring binders or GBC binding is acceptable. All binding is subject to the Engineer's approval.

C. Provide front and back covers for each manual, using durable plastic material approved by the Engineer, and clearly identified on the front cover with at least the following information:

OPERATING AND MAINTENANCE INSTRUCTIONS

FOR

MARY PASSAGE MIDDLE SCHOOL HVAC SYSTEM REPLACEMENT

(Name, addresses, and telephone numbers of Contractor and subcontractors)

(name and address of Engineer)

(Engineer's approval and date approved)

D. Contents:

1. Neatly prepared and typewritten detailed table of contents.
2. Complete instructions regarding operation and maintenance of all equipment involved, including lubrication, disassembly, and re-assembly.
3. Complete nomenclature of all parts of all equipment.
4. Complete nomenclature and part number of all replaceable parts, name and address of nearest vendor, and all other data pertinent to procurement procedures.
5. Copy of all guarantees and warranties issued.
6. Manufacturer's bulletin, cuts, and descriptive data, where pertinent, clearly indicating the precise items included in this installation and deleting, or otherwise clearly indicating, all manufacturers' data with which this installation is not concerned.
7. Such other data as required in pertinent Sections of these Specifications.

PART 3 - EXECUTION

3.1 INSTRUCTION MANUALS

A. Final Manuals: Complete the Manuals in strict accordance with the Specifications and the Engineer's review comments.

B. Submit one copy of the manual to Engineer for review.

C. Revisions: Following the indoctrination and instruction of operation and maintenance personnel, review all proposed revisions of the Manual with the Engineer.

D. Submit three copies of manual and a CD containing an electronic version of the Manual in PDF format to Engineer after completion of reviews.

END OF SECTION 017823

SECTION 017836 - WARRANTIES AND BONDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers' standard warranties on products and special warranties.

B. Refer to the General Conditions for terms of the Contractor's special warranty of workmanship and materials.

C. General closeout requirements are included in Section 017000, "Project Closeout".

D. Specific requirements for warranties for the Work and products and installations that are specified to be warranted are included in the individual Sections of Divisions 1 through 16.

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

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

1.3 DEFINITIONS

A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.4 WARRANTY REQUIREMENTS

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

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

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

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

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

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

1.5 SUBMITTALS

A. Submit written warranties directly to the Owner, with copies to the Engineer prior to the date of final payment.

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

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

D. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, one for each set, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.

1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the Project title or name, and the name of the Contractor.

E. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 017836

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

A. Work Included:

1. Throughout progress of the work, maintain an accurate record of changes in the Contract Documents, as described in this Section.
2. Upon completion of the work, transfer the recorded changes to a set of Record Documents, as described in this Section. Cross reference all changes to addenda, change orders, etc.

1.3 QUALITY ASSURANCE

A. Assign the responsibility for maintenance of Record Documents to one person on the Contractor's staff as approved by the Engineer.

B. Accuracy of Records:

1. Thoroughly coordinate changes within the Record Documents, making adequate and proper entries on each page of the Specifications and each sheet of drawings and other documents where such entry is required to show the change properly.
2. Accuracy of records shall be such that future search for items shown in the Contract Documents may rely reasonably on information obtained from the approved Project Record Documents.

C. Make entries within 24 hours after receipt of information that the change has occurred.

1.4 SUBMITTALS

A. The Engineer's approval of the current status of Project Record Documents is a prerequisite to the Engineer's approval of requests for progress payment and request for final payment under the Contract.

B. Prior to submitting each request for progress payment, secure the Engineer's approval of the current status of the Project Record Documents.

C. Prior to submitting request for final payment, submit the final Project Record Documents to the Engineer and secure his approval.

1.5 PRODUCT HANDLING

A. Maintain the job set of Record Documents completely protected from deterioration and from loss and damage until completion of the work and transfer of all recorded data to the final Project Record Documents.

B. In the event of loss of the recorded data, use means necessary to again secure the data to the Engineer's approval.

1. Such means shall include, if necessary in the opinion of the Engineer, removal and replacement of concealed materials.
2. In such case, provide replacements to the standards originally required by the Contract Documents.

1.6 MAINTENANCE OF JOB SET

A. Identify each of the job set documents with the title, "RECORD DOCUMENTS - JOB SET."

B. Preservation of Documents:

1. Considering the Contract completion time, the probable number of occasions upon which the job set must be taken out for new entries and for examination, and the conditions under which these activities will be performed, devise a suitable method for protecting the job set suitable to the Engineer.
2. Do not use the job set for any purpose except entry of new data and for review by the Engineer, until start of transfer of data to the final Project Record Documents.
3. Maintain the job set at the site of work as that site is designated by the Engineer.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe the change by graphic line and note as required. Colors that are not reproducible using standard printing procedures shall not be used.
2. Date all entries.
3. Call attention to the entry by drawing a box or other shape in a manner that avoids confusion with the original shapes and elements on the drawing around the area or areas affected.
4. In the event of overlapping changes, use different colors for the overlapping changes.

D. Make entries in the pertinent other documents as approved by the Engineer.

E. Conversion of Schematic Layouts:

1. In some cases, on the drawings, arrangements of conduits, circuits, piping, ducts, and similar items, are shown schematically and are not intended to portray precise physical layout.

   a. Final physical arrangement is determined by the Contractor, subject to the Engineer's approval.
   b. However, design of future modifications of the facility may require accurate information as to the final physical layout of items which are shown only schematically on the drawings.

2. The Engineer may waive the requirements for conversion of schematic layouts where, in the Engineer's judgment, conversion served no useful purpose. However, do not rely upon waivers being issued except as specifically issued in writing by the Engineer.

1.7 FINAL PROJECT RECORD DOCUMENTS

A. The purpose of the final Project Record Documents is to provide factual information regarding all aspects of the work, both concealed and visible, to enable future modification of the work to proceed without lengthy and expensive site measurement, investigation, and examination.

B. Review and Submittal:

1. Submit the completed set of Project Record Documents to the Engineer for approval.
2. Make required changes and promptly deliver the final Project Record Documents to the Engineer.

1.8 CHANGES SUBSEQUENT TO ACCEPTANCE

A. The Contractor has no responsibility for recording changes in the work subsequent to final completion, except for changes resulting from work performed under warranty.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017839

SECTION 018700 - MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 QUALITY ASSURANCE

A. Source Limitations: To the fullest extent possible, provide products of the same kind, from a single source.

B. Compatibility of Options: When the Contractor is given the option of selecting between two or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.

C. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products which will be exposed to view in occupied spaces or on the exterior.

D. Labels: Locate required product labels and stamps on a concealed surface or, where required for observation after installation, on an accessible surface that is not conspicuous.

E. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface which is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:

1. Name of product and manufacturer
2. Model and serial number
3. Capacity
4. Speed
5. Ratings

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle products in accordance with the manufacturer's recommendations, using means and methods that will prevent damage, deterioration and loss, including theft.

B. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.

C. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft and other losses.

D. Deliver products to the site in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting and installing.

E. Inspect products upon delivery to ensure compliance with the Contract Documents, and to ensure that products are undamaged and properly protected.

F. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.

G. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.

H. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, unused at the time of installation.

B. Provide products complete with all accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.

C. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.

D. Product Selection Procedures: Product selection is governed by the Contract Documents and governing regulations, not by previous Project experience. Procedures governing product selection include the following:

E. Semi-proprietary Specification Requirements: Where three or more products or manufacturers are named, provide one of the products indicated. No substitutions will be permitted.

F. Where products or manufacturers are specified by name, accompanied by the term "or equal," or "or approved equal" comply with the Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.

G. Non-Proprietary Specifications: When the Specifications list products or manufacturers that are available and may be incorporated in the Work, but do not restrict the Contractor to use of these

products only, the Contractor may propose any available product that complies with Contract requirements. Comply with Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.

H. Descriptive Specification Requirements: Where Specifications describe a product or assembly, listing exact characteristics required, with or without use of a brand or trade name, provide a product or assembly that provides the characteristics and otherwise complies with Contract requirements.

I. Performance Specification Requirements: Where Specifications require compliance with performance requirements, provide products that comply with these requirements, and are recommended by the manufacturer for the application indicated. General overall performance of a product is implied where the product is specified for a specific application.

1. Manufacturer's recommendations may be contained in published product literature, or by the manufacturer's certification of performance.

J. Compliance with Standards, Codes and Regulations: Where the Specifications only require compliance with an imposed code, standard or regulation, select a product that complies with the standards, codes or regulations specified.

K. Visual Matching: Where Specifications require matching an established Sample, the Engineer's decision will be final on whether a proposed product matches satisfactorily.

1. Where no product available within the specified category matches satisfactorily and also complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product in another product category, or for noncompliance with specified requirements.

L. Visual Selection: Where specified product requirements include the phrase "...as selected from manufacturer's standard colors, patterns, textures..." or a similar phrase, select a product and manufacturer that complies with other specified requirements. The Engineer will select the color, pattern and texture from the product line selected.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS:

A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.

B. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

END OF SECTION 018700

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

1.3 INFORMATIONAL SUBMITTALS

A. Material certificates.

B. Material test reports.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

1.5 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1.

1. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M).

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301 (ACI 301M).
2. ACI 117 (ACI 117M).

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

2.4 CONCRETE MATERIALS

A. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I.
2. Fly Ash: ASTM C 618, Class F.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C 595/C 595M, Type IS, Portland blast-furnace slag cement.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.

1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Water: ASTM C 94/C 94M and potable.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating.

G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, non-dissipating.

H. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

I. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.6 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 40 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.7 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Normal-Weight Concrete:

1. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Slump Limit: 4 inches (100 mm).
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) nominal maximum aggregate size.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.8 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 (ACI 301M), to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M).

C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.4 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).

3.5 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part Portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part Portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.6 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Broom Finish: Apply a broom finish to exterior concrete.

3.7 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 (ACI 301M) for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb./sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.8 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

3.9 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

END OF SECTION 033000

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Interior gypsum board.

1.3 SUBMITTALS

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

1.4 STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damage.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PANELS, GENERAL

A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD

A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. American Gypsum Co.
    b. G-P Gypsum.
    c. National Gypsum Company.
    d. USG Corporation.

B. Gypsum Board, Type X: ASTM C 1396/C 1396M; for use at or with any fire-rated wall or ceiling assemblies.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.

2. Shapes:

    a. Cornerbead.
    b. L-Bead: L-shaped; exposed long flange receives joint compound.
    c. Expansion (control) joint.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.

C. Joint Compound for Interior Gypsum Wallboard: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch-wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members, or provide control joints to counteract wood shrinkage.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Regular Type: Vertical surfaces, unless otherwise indicated.
2. Type X Fire Resistant Type: at fire barriers and firewalls as shown on the construction drawings.
3. Water Resistant Type: Toilet vertical walls.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to

greatest extent possible and at right angles to framing, unless otherwise indicated.

2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. L-Bead: Use 200B

3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 3: Unless otherwise noted.

3.6 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Acoustical Panel Ceilings shall be protected and stored for reinstallation.

B. In the event existing ceiling tiles are damaged, this Section includes patching and repair of acoustical panel ceilings installed with exposed suspension systems.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of product specified.

2. Samples for verification purposes of each type of exposed finish required, prepared on samples of size indicated below and of same thickness and material indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.

    a. 6-inch-square samples of each acoustical panel type, pattern, and color.
    b. Set of 12-inch-long samples of exposed suspension system members, including moldings, for each color and system type required.

3. Qualification data for firms and persons specified in “Quality Assurance” article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects (or Engineers) and Owners, and other information specified.
4. Product test reports from qualified independent testing laboratory that are based on its testing of current products for compliance of acoustical ceiling systems and components with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has successfully completed acoustical ceilings similar in material, design, and extent to those indicated for Project.

B. Single-Source Responsibility for Ceiling Units: Obtain each type of acoustical ceiling unit from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

C. Single-Source Responsibility for Suspension System: Obtain each type of suspension system from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

D. Coordination of Work: Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components (if any), and operable partition system.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way.

1.6 PROJECT CONDITIONS

A. Space Enclosure: Do not install interior acoustical ceilings until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:

B. Products: Subject to compliance with requirements, provide one of the following:

1. Acoustical Panel (APC-1): Mineral Base Panels – 24” by 24” by 5/8-inch thickness, square-edged; water-felted, with white painted finish and perforated and fissured Pattern, ASTM E 84, Class A fire-resistance:

a. "Minaboard Cortega 770," Armstrong World Industries, Inc.
b. "Performa Baroque BET-157," CertainTeed/St. Gobain.
c. "Radar #2110," USG Interiors, Inc.

2. Scrubbable Panels (APC-2, for installation at Kitchen food preparation areas): Mineral fiber/ceramic composite, 24" by 24" by 1/2-inch or 5/8-inch thickness, with scrubbable, white plastic paint finish, ASTM E 84, Class A fire-resistance:

a. "Ceramaguard 607," Armstrong World Industries, Inc.
b. "Performa Aquarock 1182," CertainTeed/St. Gobain.
c. "Clean Room Clima-Plus Class 100, 56099," USG Interiors, Inc.

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

1. Edge Moldings:

a. Armstrong World Industries, Inc.
b. Chicago Metallic Corporation.
c. National Rolling Mills, Inc.
d. USG Interiors, Inc.

2.2 ACOUSTICAL CEILING UNITS, GENERAL

A. Standard for Acoustical Ceiling Units: Provide manufacturers' standard units of configuration indicated that comply with ASTM E 1264 classifications as designated by reference to types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400 (plenum mounting in which face of test specimen is 15-3/4 inches 400 mm away from the test surface) per ASTM E 795.

B. Colors and Patterns: Provide products to match appearance characteristics indicated under each product type.

1. For acoustical ceiling units whose appearance characteristics are indicated by reference to ASTM E 1264 designations for pattern and not by limiting to the naming of one or more products or manufacturers, provide Engineer's selections from each named manufacturer's full range of standard products of type, color, pattern, and light reflectance indicated.

2.3 MINERAL-BASE ACOUSTICAL PANELS - NODULAR, CAST, OR MOLDED APC (APC-1)

A. Type, Form, and Finish: Provide Type III, Form 1 units per ASTM E 1264 with painted finish that comply with pattern and other requirements indicated.

B. Fissured Pattern: Units fitting ASTM E 1264 pattern designation D, with other characteristics as follows:

1. Color/Light Reflectance Coefficient: White/LR 0.75.
2. Noise Reduction Coefficient: NRC 0.65.
3. Ceiling Sound Transmission Class: CSTC 35.
4. Edge Detail: Square.
5. Size: As shown on the drawings.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension Systems shall be existing to remain.

2.5 MISCELLANEOUS MATERIALS

A. Concealed Acoustical Sealant: Nondrying, non-hardening, non-skinning, non-staining, non-bleeding, gunnable sealant complying with requirement specified in Division 7 Section "Joint Sealers."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and structural framing to which ceiling system attaches or abuts, with Installer present, for compliance with requirements specified in this and other sections that affect installation and anchorage of ceiling system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.

1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

B. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders, and comply with reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical ceiling systems to comply with installation standard referenced below, per manufacturer's instructions and CISCA "Ceiling Systems Handbook."

1. Standard for Installation of Ceiling Suspension Systems: Comply with ASTM C 636.
2. Standards for Installation of Ceiling Suspension Systems: Comply with ASTM C 636 and ASTM E 580.

B. Arrange acoustical units and orient directionally patterned units in a manner shown by reflected ceiling plans.

C. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.

1. Install hold-down clips in areas indicated and in areas where required by governing regulations or for fire-resistance ratings; space as recommended by panel manufacturer, unless otherwise indicated or required.

3.4 CLEANING

A. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 230100 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This Section forms a part of all Division 23 Sections.

1.2 APPLICABLE SPECIFICATIONS, CODES AND STANDARDS

A. Latest effective publications of following Specifications, regulations, standards, codes, etc., as applicable, form a part of these Specifications the same as if written fully herein and shall be followed as minimum requirements.

Codes and ordinances of local governing agencies:

AGA	American Gas Association
AHRI	Air Conditioning, Heating and Refrigeration Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standard Institute
ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
IEEE	Institute of Electrical and Electronics Engineers
NAFM	National Association of Fan Manufacturers
NEC 2017	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
SMACNA	Sheet Metal and Air-conditioning Contractors National Association
UFAS	Uniform Federal Accessibility Standards
UL	Underwriters Laboratories, Inc.
VFSR	Virginia Fire Safety Regulations
VUSBC	Virginia Uniform Statewide Building Code, 2018 Edition

1.3 DRAWINGS

A. General arrangements of indicated piping, ductwork and equipment are diagrammatic only, do not scale. Where rearrangement is necessary, submit drawings of proposed changes for approval. Due to scale of drawings, offsets, fittings and accessories may not be indicated. Work indicated, but having details omitted, shall be provided complete to perform function intended without extra

cost. Investigate existing structural and finish conditions in building affecting plumbing, heating, ventilating and air-conditioning work, etc., and arrange work accordingly. Furnish fittings, traps, offsets, vents, valves and accessories required. Install equipment in accordance with manufacturer's recommendations and clearance requirements.

1.4 COORDINATION

A. Coordinate piping, ducts and equipment with electrical plans and work in order to avoid omissions and to eliminate any interference. Report in writing discrepancies, if found, to the Engineer as soon as possible after discovery.

1.5 WORKMANSHIP

A. Workmanship shall be first class and of best quality in accordance with approved contemporary construction practices. Defective equipment and materials, or material damaged in the course of installation and tests shall be replaced or repaired in an approved manner.

1.6 CUTTING

A. Cutting shall be carefully done. Repair damage to the building, piping, wiring, or equipment as a result of cutting for installation, using skilled mechanics of trade involved.

1.7 APPROVAL OF MATERIALS, FIXTURES AND EQUIPMENT

A. See Specification Section 013300 "Submittal Procedures" for shop drawing submittal procedures. Within 30 days after award of the Contract and before any purchases are made, submit for approval a complete list of materials, fixtures and equipment proposed, together with names of manufacturers and catalog numbers for each Specification Section. Furnish other detailed information where directed. No consideration will be given to partial lists submitted from time to time. Approval of materials shall be based on manufacturer's published ratings. Materials, fixtures and equipment listed which are not in accordance with specified requirements shall be rejected. Contractor shall make resubmission of items not approved within 30 days from date of rejections. Submission shall be complete with description, ratings, dimensions and related items and any additional information required by the Engineer.

B. Materials and equipment shall be new, conforming to these Specifications.

C. Two or more units of same class of equipment shall be product of single manufacturer; however, component parts of system need not be product of same manufacturer.

D. Mechanical design has given full consideration to space requirements for equipment specified. Contractor is responsible for selecting equipment that will be accommodated by this space. Equipment not conforming to space allotted shall be rejected.

E. Mechanical design has given full consideration for electrical requirements for equipment. Contractor is responsible for selecting equipment that will be accommodated by the electrical design indicated. Equipment not conforming to the electrical design provided under Division 26 is the Contractor's responsibility. All electrical changes required to accommodate the equipment provided shall be furnished and installed by the Contractor without change in Contract price or time of completion. This shall include but not be limited to wiring, conduit, circuit breakers, disconnect switches, starters and controllers.

F. Submit one copy of equipment installation manuals to the Engineer for his use.

1.8 EQUIPMENT DESIGN

A. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with ASME, ANSI, IEEE, or other applicable technical standards, suitable for maximum working pressure and shall have neat and finished appearance.

1.9 SUPERVISION

A. The Contractor for each Section under this Division shall maintain a competent foreman on the job at all times to supervise the work and coordinate with other trades for the installation of the system. Submit foreman's qualifications, including master's trade license, to the Engineer for approval.

1.10 NOTICES AND FEES

A. Give all required notices, obtain all necessary permits (including a separate permit for the installation of refrigerant lines if required by the local "Authority Having Jurisdiction") and pay all required fees.

1.11 RECORD DRAWINGS

A. Refer to Specification Section 017839 "Project Record Documents".

1.12 OPERATION AND MAINTENANCE MANUALS

A. Refer to Specification Section 017823 "Operation and Maintenance Data".

1.13 OWNER'S TRAINING

A. Upon completion of work and at a time designated by the Owner, the services of competent persons shall be provided as required to instruct Owner's representative in operation and maintenance of systems. Training sessions shall be a combination of on-site and in-classroom

training and shall be a minimum of two 8-hour sessions. All training shall be video recorded by the Contractor and provided in electronic format.

1.14 WARRANTY-GUARANTEE

A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of materials and workmanship for a period of 12 months from date of Substantial Completion.

B. Contractor shall service the systems for 12 months from date of Substantial Completion. Such service shall include all emergency services and adjustments, except cleaning/changing of filters**.** Adjustments and repairs to equipment shall be made by the original equipment manufacturer (OEM). Third party service agencies are not acceptable for making repairs or adjustments to equipment during the warranty period.

C. The equipment manufacturer and Contractor shall provide a one-year material, labor and refrigerant warranty on all compressors. In addition, the manufacturer shall provide a material only warranty on all compressors for a period of 5 years total, beginning at the date of Substantial Completion.

D. Contractor shall be responsible for cleaning of hydronic system strainers during the warranty period and provide a report from a water treatment specialist certifying the hydronic systems have been drained, flushed, filled, vented and chemically treated as required by these specifications and that the system is clean and free of contamination and any other foreign matter and ready for use by the Owner.

1.15 WELDER'S CERTIFICATIONS

A. Submit welder's certifications to the Engineer/Architect for approval.

1.16 TEMPORARY HVAC REQUIREMENTS

A. Contractor shall be responsible for all temporary cooling, heating, and dehumidification equipment to maintain the space temperature and humidity below the maximum limits of 78°F DB and 60% RH. Provide equipment with capacity as shown on the project drawings.

B. Temporary cooling, heating, and dehumidification equipment shall be provided for each of the following spaces:

a. Library

PART 2 - PRODUCTS

2.1 STEEL PIPE FITTINGS

A. Welding fittings shall be carbon-steel buttwelding type, conforming to ASME B16.9 and B16.28. Flanges shall be carbon steel, conforming to ANSI B16.5.

C. In lieu of welding fittings, BONNEY FORGE “Weldolets”, “Sockolets” and “Threadolets” may be used for branch connections when the diameter of the branch connection does not exceed 50% of the diameter of the main.

2.2 PIPE SLEEVES, PIPE HANGERS, PIPE SUPPORTS, AND DUCT SUPPORTS

A. Provide pipe sleeves, hangers, supports, and duct supports. Contractor shall be responsible for proper and permanent location. Pipe and duct shall not be permitted to pass through footings, beams, or ribs, unless indicated and/or approved. All piping passing through masonry or concrete walls shall be sleeved and insulation shall run continuously through sleeve.

B. Install pipe sleeves and properly secure in place with grout where pipes pass through masonry or concrete walls and at all fire-rated assemblies. Pipe sleeves shall be sufficient diameter to provide approximately 1/4" clearance around insulation or pipe. Fill void between insulation or pipe and sleeve with mineral wool to prevent sound transmission. Pipe sleeves in walls and partitions shall be Schedule 40 steel pipe.

C. Hang horizontal overhead runs of pipe with adjustable clevis-type hangers spaced not over 10 feet apart, except space soil pipe hangers not over 6 feet apart. Provide hangers other than aforementioned, if pipe size or other features make spacing at shorter intervals necessary. Pipe hangers shall be provided within 4 feet of all changes in direction of pipe. Pipe hangers shall not be installed on pipe fittings where fitting could bear the weight of connected pipe but instead shall be installed on pipe at intervals previously specified. Chain, strap, perforated bar, or wire hanger will not be permitted. Hangers shall have short turnbuckles or approved means of adjustment. Use spring-type hangers where required. Use trapeze hangers on pipes running parallel and close together. Support vertical runs of pipe by clamps or collars spaced not over 20 feet apart or as required. Support chromium-plated pipe where required by cast-brass supports finished to match pipe. Hangers, including rods and clamps, shall be hot dipped galvanized exterior to the building and in all mechanical spaces, zinc plated in all interior spaces, except as otherwise specified.

D. Supports for piping, ductwork and equipment shall be attached to a structural member, not bridging. Piping, ductwork and equipment shall not be attached to structural joist bridging or metal roof or floor decking. Provide additional steel supports spanning between joists or beams for hanger attachments. Additional steel supports shall be approved by the Structural Engineer.

E. In areas supported by steel beams, secure hanger rods directly to beams.

F. Provide galvanized steel shields or protection saddles to protect insulation at area of contact with hangers and supports. Where shields are used on pipes 1-1/2" and larger, provide insulation inserts at points of hangers and supports. Refer to Specification Section 230700 “Mechanical Insulation”, for details.

G. Support and fasten equipment in an approved manner.

H. Ductwork shall be supported in accordance with SMACNA, HVAC Duct Construction Standards, unless otherwise noted or indicated. Ductwork shall be supported using threaded rod or solid metal strap as required by SMACNA. No other materials, such as perforated metal strap, or cloth strap, are acceptable. Wire may be used to hang round duct smaller than 10"; however, solid metal strap shall be used to wrap around duct. Wire shall not be used for rectangular duct or round duct larger than 10".

2.3 DUCT AND PIPE PENETRATIONS THROUGH FLOORS, WALLS AND CEILINGS

A. Fit exposed pipes passing through finished walls with escutcheon of chromium-plated cast-brass plates on chromium-plated pipe, nickel-plated steel plates on ferrous pipe, or copper tubing. Plates shall be large enough to completely close hole around pipes and conceal pipe sleeves and shall be round, with least dimension at least 1/2" larger than diameter of pipe and insulation. Secure plates in an approved manner.

B. Fit ductwork passing through floors, walls, or ceilings with 22-gauge galvanized sheet-metal sleeves. Sleeves shall be large enough to completely close hole around duct and shall be at least 1/2" larger than outside dimensions of duct and insulation. Provide flanges on both sides of penetrations to cover the wall edge. For uncovered ducts, sleeves shall be of same material as duct. Secure sleeves and flanges in an approved manner.

C. Ducts passing through floors shall be sealed with a UL rated system appropriate for the specified fire rating.

D. Pipes passing through firewalls, smoke partitions, or fire partitions shall be sealed with a UL-rated system appropriate for the specified rating.

2.4 UNIONS

A. Unions shall be installed on each side of all control valves, regulators and similar items and one side of all pieces of equipment, such as pumps, tanks, etc., so that such equipment shall be readily disconnected and removed if necessary.

2.5 DIELECTRIC CONNECTIONS

A. Dielectric connections shall be provided at all connections between ferrous and nonferrous piping or metals, except drain piping connections at drain pans for cooling coils and valves having cast-bronze adapters.

2.6 ELECTRICAL WORK FOR EQUIPMENT UNDER MECHANICAL SYSTEMS

A. All non-integrated motor controllers and starters serving equipment installed under Division 23 Sections shall be furnished under those Sections and shall be turned over to Electrical Contractor, for installation by Electrical Contractor. Controllers shall be equipped with all auxiliary contacts, poles, or devices necessary to permit interlocking and control required.

B. Fractional horsepower motors 1/2 HP and below shall be single-phase, 60 cycles, 120V; motors larger than 1/2 HP shall be 3-phase, 60 cycles, of voltages indicated on the electrical drawings and conforming to the electrical service, except where indicated otherwise. Motors shall conform to latest NEMA requirements.

C. All electrical power wiring required for equipment installed under Division 23 Sections shall be provided under Division 26 Sections with all necessary approved wiring diagrams and guidance provided under Division 23 Sections, with the exception of power wiring to Automatic Temperature Control panels which shall be provided by the Automatic Temperature Control Contractor.

D. Raceways shall be 1/2" minimum. All wiring in rooms with exposed structure or in inaccessible ceiling and walls shall be installed in conduit. Label the front face of the cover on each junction box with indelible black marker indicating the number of each circuit contained in or running through the box. In areas where exposed construction is the final finished condition and conduit and junction boxes are called out to be painted, label the inside face of the covers.

E. All control and power wiring required for temperature control system and all interlocking and accessory control wiring required for equipment installed under Division 23 Sections shall be installed by the Plumbing, Mechanical and Temperature Control Contractors.

F. Three-phase motors shall have magnetic across-the-line starters unless hereinafter indicated or required by Power Company to be otherwise. Provide overload relay in each phase or motor lead. Operation of any overload relay shall simultaneously open all phases.

G. Starters for motors under automatic control shall have built-in “hand-off-auto” selector switch.

H. Push-button stations shall have “start-stop” momentary contacts, having one normally open and one normally closed set of contacts, with indicating lights to indicate when motors are running. Stations shall be heavy-duty type designed for flush or surface mountings as required.

I. All starters and controls shall be NEMA rated and NEMA I enclosed where mounted inside building, except in kitchens which shall be NEMA 4X-SS. Starters and controls mounted outside or where specifically called for shall be NEMA 3R. Combination switch and magnetic starters shall be provided where indicated.

J. Auxiliary 120-Volt contacts shall be provided to give control and interlocking as required or as indicated.

K. Where control voltages are different from motor voltages, a control-voltage transformer shall be provided as a part of the starter.

L. The Contractor shall be responsible for coordinating with the Division 26 Contractor for providing properly sized circuit breakers to serve equipment and motors furnished which differ from that specified or indicated. This shall be further understood to include branch circuit wiring, conduit, disconnect switches, etc., in accordance with the appropriate codes and specifications. The cost of providing this increased electrical service and related work shall be included under the applicable section under which the equipment and motors are being furnished, at no additional cost to Owner.

M. The Automatic Temperature Controls Contractor shall be responsible for providing circuit breakers and power wiring and conduit from electrical panels installed under Division 26 to Automatic Temperature Controls panels. All electrical work shall be in accordance with appropriate codes and Division 26 specifications.

N. Short-Circuit Current Rating (SCCR) on HVAC equipment nameplates:

1. The nameplate for all HVAC equipment with overcurrent protection greater than 60 amps shall be provided with SCCR in accordance with the National Electric Code (NEC) Article 440.4(B). The SCCR shall meet or exceed the SCCR indicated on the contract documents.
2. The nameplate for all HVAC equipment with overcurrent protection equal to 60 amps or less are not required to be provided with SCCR. However, if the manufacturer of the HVAC equipment chooses to list the SCCR on the equipment nameplate, they shall comply with NEC Article 440.4(B) and the SCCR shall meet or exceed the SCCR indicated on the contract documents.

2.7 AIR BALANCING DEVICES

A. Furnish any additional material or equipment, such as sheaves, belts, motors and balancing devices, required to complete and/or adjust and balance the systems as recommended by the TAB Agency at no additional cost to the Owner. Failure to provide additional means of adjusting and balancing will not relieve the Contractor of responsibility for properly adjusting and balancing the various systems as intended.

2.8 DUCT SEALANT

A. Where duct is indicated to be sealed, utilize a fire resistive, water based, indoor/outdoor, U.V. resistant, non-fibrated duct sealant, DUCTMATE EverSeal, FOSTER DUCT-FAS 32-19 or approved equal.

B. Sealant shall have a volatile organic compound (VOC) rating of 24 g/L, less water.

C. Sealant shall meet all SMACNA pressure classes up to 10” w.g. and SMACNA seal classes A, B and C.

D. Apply sealant with brush working sealant into all joints. For spiral duct, apply sealant to male end of coupling prior to fitting straight run of duct to coupling. Follow manufacturer's instructions for all application requirements.

E. The use of duct sealing tape of any kind is unacceptable.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. Pipe systems shall be complete. Pipe shall be of size indicated or, where not indicated, shall be of size required to produce capacities of the equipment specified. No pipe shall be buried in floors, unless specifically indicated or approved.

B. Install runs of piping as indicated. Cut pipe accurately to measurements established at the building by the Contractor and work into place without springing or forcing. Do not cut or move any structural portions of the building without approval. Run piping above ground, parallel with lines of buildings, unless otherwise shown or specified.

C. Install piping to allow for expansion and contraction, using offsets, swing joints, expansion joints, anchors and related items as may be necessary. Make connections to coils, pumps and other equipment in such manner as to eliminate undue strains in piping and equipment and to prevent noise transmission. Provide necessary fittings and bends to avoid springing of pipes during assembly. Weld expansion loops using long-radius ells. Make changes in pipe sizes with reducing fittings.

D. Pipe outlets of vent valves, safety valves, drip pans, overflow drains, condensate drains, backflow preventers and other drain points to floor drain unless otherwise indicated. Gages, thermometers and related items shall be carefully leveled. Thoroughly clean and flush piping in presence of the Engineer, as installed and before automatic vents are installed.

E. Unless otherwise indicated, connections to equipment shall be as shown by manufacturer's data. Make piping connections to equipment with unions or flanged connections arranged so that equipment can be dismantled without disturbing the piping installation. Unions shall be accessible after building is complete. Provide valves to isolate equipment for service or removal.

F. Run horizontal water piping with pitch of at least 1" in 40'-0" and arrange to drain to minimum number of low points. Equip low points with drain valves and hose nipples not smaller than 3/4". Eccentric reducing fittings or eccentric reducing couplings must be installed where indicated or as required to bring bottoms of mains in line and prevent pockets. Pitch closed loop water piping to vent at high points. Provide a manual air vent ball valve at all high points in the piping system.

G. Close pipe openings with caps or plugs during installation. Cover equipment tightly and protect against dirt, water and chemical or mechanical injury. Carefully free interior of pipe of superfluous material as work progresses. Upon completion of work, thoroughly clean materials and equipment and deliver in approved unblemished condition.

H. Ream pipe after cutting and before threading and remove burrs. Make screwed joints with graphite and oil or approved graphite compound applied to threads only. Cut threads full and not more than three threads on pipe shall remain exposed. Caulking of threaded joints to stop or prevent leaks will not be permitted. Provide unions where required for disconnection. Use swing joints for branch connections to risers and mains.

I. The Contractor may, except at unions, weld pipe 2-1/2" and larger, using welding fittings. Welding material and labor shall be in accordance with an approved procedure conforming to ASME B31.9 Building Services code. Welders shall be fully qualified by an approved Welding Bureau or locally recognized testing authority. Welding shall be electric arc welding method. Welding of pipe inside the building shall not be permitted without approved ventilation. Galvanized pipe shall have the galvanizing ground from the heat affected zone.

3.2 GROUTING

A. Grout heavy equipment with Embeco pre-mixed grout. MASTER BUILDERS COMPANY. Follow manufacturer's instructions on container. Use Mix No. 1 where clearance between bedplate and foundation is 1" or less; for other clearances, use Mix No. 2. Use only where grout is confined or held under restraint.

3.3 EQUIPMENT INSTALLATION

A. Erect equipment in neat and workmanlike manner. Align, level and adjust for satisfactory operation. Install so that connecting of piping and accessories can be made readily and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviation from indicated arrangements may be made as approved by Engineer.

3.4 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Design and construct supporting structures of strength to safely withstand stresses to which they may be subjected and to distribute properly the load and impact over building areas. Conform to applicable technical societies' standards, also to codes and regulations of agencies having jurisdiction. Obtain approval before fabrication.

B. Locate supports for tanks so as to avoid undue strain on shell and interference with pipe connections to tank outlets.

C. For tanks containing tubes, check support locations for clearance to pull tubes.

D. Fasten wall-mounted or ceiling-hung equipment to building structures or inserts as approved.

E. Where concrete foundations or pedestals are indicated or required, use concrete mix, reinforcement where required and methods as specified under Section 033000 "Cast-In-Place Concrete".

F. Where floor is waterproofed, construct foundation so that anchor bolts will not pierce waterproofing.

G. Finish exposed parts of concrete foundation with cement mortar. Fill voids, trowel smooth, bevel edges and corners to make neat appearance.

H. Provide adequate supports for roof-mounted mechanical equipment. Supports shall keep equipment clear of roof and transmit weight to roof structure as approved by Engineer.

I. The Contractor shall submit for review physical data for each unit supported from the building structure, either suspended from or attached to the building structure. The physical data shall include the equipment operating weight, corner weights, and center of gravity.

3.5 NOISE AND VIBRATION

A. Mechanical and electrical equipment shall operate without objectionable noise or vibration as determined by the Engineer/Owner.

B. If such objectionable noise or vibration should be produced and transmitted to occupied portions of building by apparatus, piping, ducts, or other parts of mechanical and electrical work, make necessary changes and additions as approved, without extra cost to the Owner.

C. Isolators shall prevent, as far as practicable, the transmission of vibration, noise, or hum to any part of building.

D. Isolators shall suit vibration frequency to be absorbed. Provide isolator units of area and distribution to obtain proper resiliency under load and impact.

3.6 CONCRETE PADS

A. Concrete shall conform to requirements of Section 033000 “Cast-In-Place Concrete”.

3.7 FLASHING

A. Provide cap flashing for roof-mounted fans and the like.

3.8 PROTECTION OF EQUIPMENT AND MATERIALS

A. Responsibility for care and protection of mechanical equipment rests with Contractor until Substantial Completion of the work.

B. After delivery, before and after installation, protect equipment and materials against theft, injury, the environment, or damages from all causes.

C. Protect equipment outlets and pipe openings with temporary plugs or caps.

D. During construction, seal off all openings into interior of equipment and ductwork with sheet metal or taped polyethylene sheathing to prevent infiltration of dust.

E. Temporary MERV 8 filters shall be provided a minimum of every 14 days for all fans that are operated during construction and new MERV 8 filters shall be installed after all construction dirt has been removed from the building just prior to testing and balancing. Following the testing and balancing, MERV 8 filters shall be provided a minimum of every 14 days for all fans that are operated during construction. Just prior to Final Completion, all filters shall be replaced with the final MERV 13 filters. Ducts shall be inspected for dust and dirt. Contractor shall provide a signed statement to indicate that new filters for each piece of equipment were installed just before Final Completion. Construction filters shall be removed and not be used as the final set of filters. The contractor shall keep a filter replacement log that includes equipment identifications and dates of filter installation. Log shall be provided to the Engineer and Owner for review on a monthly cycle. Should the Contractor fail to comply with the filter changes as specified, the Owner may, at his discretion, hire through a separate contract the specified filter changes and withhold the cost for this work from the construction contract amount as a back charge to the Contractor.

F. Provide a spare filter (or sets of filters for equipment that require multiples) for each piece of equipment. Turn filters over to Owner with proper transmittal prior to Final Completion.

G. Equipment not designed for exterior installation (i.e., AHU internal components, VAV terminal boxes, inline exhaust fans, duct heating coils, cabinet unit heaters, etc.) shall not be delivered to the job site until a location protected from the environment is provided. Location must be approved by the Architect and Engineer prior to delivery.

H. Equipment suitable for exterior installation (i.e., roof mounted exhaust fans, Kitchen supply and exhaust fans, etc.) shall not be delivered to the job site until it is ready to be installed in its permanent location.

3.9 CONTRACTOR'S RESPONSIBILITY FOR MANUFACTURER'S AUTHORIZED FIELD START-UP

A. The equipment manufacturer shall furnish a factory-trained and certified service technician without additional charge to start the HVAC equipment. This individual's certifications shall be submitted as a shop drawing along with the equipment and shall be reviewed and approved by the Engineer. Unit manufacturers shall maintain service capabilities no more than 100 miles from the job site.

B. The HVAC equipment to be started by the manufacturer's certified technician shall include:

1. Chillers
2. Boilers
3. Pump packages

C. The manufacturer shall furnish complete submittal wiring diagrams of the HVAC equipment as applicable for field maintenance and service.

D. Start-up sheets on all equipment shall be submitted and reviewed by the engineer. An approved copy shall be included in the final TAB report. If required, this same representative shall be made available to review the startup sheets onsite with the Engineer and Owner.

3.10 CONTRACTOR'S RESPONSIBILITY FOR TESTING, ADJUSTING AND BALANCING (TAB)

A. Provide the TAB Agency a full set of Contract Documents (drawings and technical specifications), all manufacturers' approved submittal data and copies of revised data as soon as possible.

B. Ensure that a current TAB Engineer's certification certificate is kept on file.

C. Ensure all systems have been installed and are in 100% working order before the TAB Engineer is called to the job site, including but not limited to ductwork, piping, terminals, electrical and ATC. The Contractor shall verify that each item of the Pre-TAB Checklist (see Appendix A) has been completed and shall deliver a signed copy of the Pre-TAB Checklist to the Owner's Representative and the TAB Agency attesting that the project is complete and ready for TAB work to begin.

D. Ensure that all ductwork requiring SMACNA – ADLTM duct leakage testing has been tested in the presence of the TAB Engineer and Owner's Representative and has met the referenced requirements.

E. Provide adequate access to all points of measurement and adjustment and ensure that all dampers operate freely.

F. Provide a factory representative for all major pieces of equipment as requested by the TAB Agency to assist in operation and performance verification of equipment.

G. Cooperate with the TAB Agency to help operate and adjust the control systems directly related to TAB work and provide any specialties required to make such adjustments.

H. Carefully review the drawings and Specifications for the various systems noting all facilities incorporated in the design for purposes of adjusting and balancing. Should it be deemed necessary to provide additional dampers, baffles, valves, or other devices which would aid in the required adjusting and balancing, same shall be provided by the installing contractor.

3.11 CLEANING, PAINTING AND IDENTIFICATION

A. Remove from site excess material, equipment protection, etc. Thoroughly clean piping, hangers, equipment, fixtures and trimmings and leave every part in perfect condition ready for use, painting, or insulation as required.

B. Paint exterior surfaces of equipment supports and other ferrous metal work, except that which is galvanized, with one coat of RUSTOLEUM damp-proof red primer, or approved equal.

C. Water piping service and flow direction shall be indicated with outdoor grade 3.2 mil thick high gloss adhesive backed vinyl labels which identify the service by name (not initials) and the flow direction by arrows. Provide labels similar to Brimar, EZ Pipe Markers with arrow banding tape wrapping the pipe 360°. Labels shall be used wherever piping is exposed, except in finished spaces, at all unit connections and at 25-foot intervals for concealed piping located above accessible ceilings. Label and arrow heights shall be proportional to pipe sizes as follows:

Insulated and Un-Insulated Pipe Size	Label Heights
Up to 1"	1"
1-1/4" to 2"	2"
2-1/2" to 4"	3"
4" and above	4"

D. All valves in equipment room(s) shall be identified with 1-1/2" diameter, permanently stamped, brass tags. Secure tags to valve item or wheel with brass jack chain or copper meter seals. Provide framed and mounted, under clear plastic, valve chart (8-1/2 x 11 min.), identifying valve number by system served and function.

E. Provide seals, signs and tags on fire protection equipment at designated locations per NFPA.

F. Provide color-coded identification dots affixed to the ceiling grid for equipment, access doors, terminal equipment controllers, smoke detectors, filters and valves concealed above ceilings. Provide a color-coded chart identifying type of equipment or valve. Chart shall be framed and mounted, under clear plastic and located as directed by Owner.

3.12 EQUIPMENT MARKING

A. Label all mechanical equipment, including starters, control panels, boilers, chillers, fans, VAV boxes, pumps, air-handling units, and thermostats.

B. Labels shall be machine engraved, laminated, 1/8” thick, Bakelite, nameplate type. Labels shall be black faces with white letters.

C. Labels shall have 1/4" high letters.

D. Labels shall be rigidly attached using rivets or screws. Adhesive backing is not acceptable.

E. Thermostat labels shall be a self-adhesive type. Labels shall identify the equipment served by the thermostat.

3.13 EQUIPMENT INVENTORY

A. Provide a complete equipment inventory for all Mechanical equipment included in the project scope of work. Refer to Appendix B of this section for the required template. A separate form shall be provided for each new piece of equipment provided.

B. Prior to substantial completion, submit the equipment inventory forms for review. Once approved, include the forms in the operation and maintenance manual.

APPENDIX A

PRE-TAB CHECKLIST

A. GENERAL

1. All components of the HVAC system have been installed, including controls and control wiring.
2. Power wiring has been installed and energized to all motorized equipment. Also, all line voltage control wiring required has been installed.
3. All equipment has been started and run tested through all specified sequences of operation by factory-authorized representatives and all safety controls have been verified to be operational.
4. All required testing of piping and duct systems has been completed in accordance with the drawings and specifications.
5. Duct leakage testing, where required, shall be witnessed by the Owner's Representative and/or the TAB Agency.

B. HVAC WATER DISTRIBUTION SYSTEMS

1. Piping systems have been flushed thoroughly, strainers have been removed, cleaned and replaced as required. There is no evidence of plugged piping, coils, heat transfer equipment, valves, or flow measuring devices.
2. All air has been vented from the hydronic piping systems, equipment and coils.
3. Pressure reducing/regulator valves in make-up water piping have been set for the required fill pressure of each hydronic system.
4. Correct pump rotation has been verified. Pumps are not cavitating. Vibration isolators and flexible connectors have been installed where required. Vibration is not excessive with pumps operating. Pumps have been lubricated.
5. All control valves are installed and functioning properly according to the specified sequences of operation.
6. All required pressure, temperature and flow measuring devices and balancing valves have been installed. All taps and adjustment dials are accessible and adequate clearances have been provided for connection of instrument hoses and adjustment taps, dials and scales are free of paint, insulation mastic and other foreign matter.
7. System contains correct amount of water treatment chemicals and glycol where required.

C. AIR DISTRIBUTION AND VENTILATION SYSTEMS

1. All air system filters have been replaced with new filters. The air moving equipment, ductwork and air terminals are installed and connected. All air systems are unobstructed and free of debris.
2. All manual volume control dampers required are installed and properly connected to adjustment handles. All damper handles are accessible and not covered by insulation or draw bands. All automatic dampers required have been installed with linkages connected and adjusted to provide the specified sequence of operation.

3. Access doors have been installed where required to allow inspection and servicing of duct-mounted dampers, equipment and components.
4. All ductwork and connections of duct to air terminals have been checked and no visible or audible leakage exists.
5. Fans are rotating in correct direction. Fans have been lubricated. Drive pulleys are aligned and belt tension is correct. Setscrews are tight securing keys into key-ways. Fan wheels turn freely and are balanced. Belt guards are in place.
6. Vibration isolators and flexible connectors have been installed where required. With fans in operation, there is no excessive vibration of fan assemblies or ductwork.

I, _____ an authorized representative of
(Signature and Title)

_____
(Company)

attest that all items contained in the above Pre-Tab Checklist have been completed

and verified as of this date:_____.

APPENDIX B

Equipment Inventory Template

Project Name: **(Add Project Name)**

Project Address: **(Add Project Address)**

Description of Item: _____
(i.e., Air Handling Unit, Ductless Split System, etc.)

Classification:
- ☐ HVAC
- ☐ Plumbing
- ☐ Fire Protection

Building: _____

Equipment Location (Room Number): _____

Date Purchased: _____

Date Placed in Service: _____

Original Cost: _____

Life Expectancy (years): _____

Estimated Replacement Date: _____

Estimated Replacement Cost: _____

Manufacturer: _____

Model/Serial #: _____

END OF SECTION 230100

SECTION 230500 - HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 “Mechanical General Provisions” apply to this Section.

B. Refer to Specification Sections 230900 “Automatic Temperature Controls” and the Control Diagrams on drawings for additional requirements and coordination between equipment and controls.

1.2 WARRANTY-GUARANTEE

A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of material and workmanship for a period of 12 months from date of Substantial Completion of the building. Refer to Section 230100 for additional warranty period responsibilities.

1.3 SUBMITTALS

A. Submit manufacturer’s performance data and unit details on all products specified below or indicated on drawings.

1.4 PROTECTION OF EQUIPMENT AND MATERIAL

A. All equipment and material not specifically designed for exterior installation shall not be delivered to the job site until an indoor, dry location is available for storage. All equipment and material shall be covered and protected from dirt, debris, moisture, paint, coatings and damage of any kind. Store off the floor, in a location approved by the Owner, to prevent contact with water.

B. All air-conveying equipment and material, including but not limited to variable air volume terminal boxes, air handling units, exhaust fans, diffusers, and ductwork shall be kept clean as described above and all airside surfaces shall be wiped clean (metal surfaces) prior to installation. Where equipment surfaces are subject to additional accumulation of dirt and debris, interior cleaning shall be done after the completion of ductwork installation at all unit openings.

1. Exterior surfaces of all equipment shall be cleaned at completion of construction in a manner that condition and appearance of equipment is the same as it left the factory.

2. No equipment shall be run without approval by the Engineer. Prior to granting approval, the Engineer will require the building to be broom swept clean without air bourn dust which can be pulled into the duct system. An individual area of the building may be partitioned off for temporary use of the HVAC system provided a partition is erected to separate it from the dirty areas and the air handler is adjusted to positively pressurize the conditioned area. The Contractor shall provide temporary filters for all intakes and return connections to air-conveying equipment at his own expense during the construction process in accordance with Specification Section 230100. Generally, a 2-inch MERV 8 temporary filter shall be placed over the return opening followed by two layers of blue construction filter media. The outer layer of blue media shall be changed weekly or sooner if the media is no longer blue. At all times the filter media must be monitored for breakthrough. Maintain a filter log to record all inspections and changes. Filters shall be changed every 14 days regardless of condition. The Contractor assumes full responsibility for cleanliness of all equipment operated during the construction period and any ductwork used to convey air during construction prior to meeting Substantial Completion. If dust migrates into the duct system, it must be professionally cleaned. The Contractor shall clean all equipment to like-new condition as it appeared when it left the factory prior to substantial completion. All damages shall be repaired/replaced at the Contractor's expense.
3. Operation of the HVAC system during construction requires the safeties and duct smoke detectors to be operational to protect the building and personnel.

PART 2 - PRODUCTS

2.1 HEAT GENERATION

A. Boiler:

1. Contractor shall furnish and install full condensing boilers in accordance with the following specifications and capacities as shown on the plans. Basis of Design is LOCHINVAR "CREST" or approved equal. FULTON boilers will not be accepted per Newport News Public Schools Design Standards.
2. Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
3. Heat Exchanger: The heater exchanger shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 30,000 to 40,000 Btu's per tube. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger design. Cast iron, aluminum, or condensing copper tube boilers will not be accepted.
4. Condensate Collection Basin: Fully welded 316L stainless steel.

5. Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.
6. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 2.4 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than 157 gallons.
7. Burner: Natural gas, forced draft single burner premix design with an upper and lower chamber supplied by individual combustion systems. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall have an independent laboratory rating for Oxides of Nitrogen (NOx) to meet requirements of South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2.
8. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.

9. Gas Train: The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of the following minimum turndowns:

Model	Turndown	Minimum Input	Maximum Input
FB 2501	20:1	125,000	2,500,000

10. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

11. Casing:

    a. Jacket: Heavy gauge primed and painted steel jacket with snap-in closures.
    b. Control Compartment Enclosures: NEMA 250, Type 1A.
    c. Insulation: Minimum ½ inch thick, mineral fiber insulation surrounding the heat exchanger.
    d. Combustion-Air Connections: Inlet and vent duct collars.

12. Vibration Isolators

    a. Provide neoprene waffle-type vibration isolators for each corner of the unit.

13. Characteristics and Capacities:

    a. Heating Medium: Hot water.
    b. Design Water Pressure Rating: 160 psi working pressure.
    c. Safety Relief Valve Setting: 50 psig
    d. Minimum Water Flow Rate: 25 GPM

14. Trim:

    a. Safety Relief Valve:

        1) Size and Capacity: 50 lb.
        2) Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

    b. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.
    c. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.
    d. Condensate Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.

15. Controls:

    a. Refer to Division 23 Section "Automatic Temperature Controls".

    b. Boiler controls shall feature a standard, factory installed 8” LCD screen display with the following standard features:

        1) Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
        2) Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
        3) Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
        4) Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
        5) Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
        6) PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
        7) Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
        8) Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
        9) Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
        10) Night setback: Boiler shall be programmed to reduce the space heating temperature set point during a certain time of the day.

11) Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps shall turn off when the boiler water temperature rises above 43 degrees.
12) BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
13) Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.

c. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:

1) Lead lag:
2) Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.
3) Front end loading:
4) Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.

d. Boiler operating controls shall include the following devices and features:

1) Set-Point Adjust: Set points shall be adjustable
2) Operating Pressure Control: Factory wired and mounted to cycle burner.
3) Sequence of Operation: Electric, factory-fabricated and factory-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 35 deg F outside-air temperature, set supply-water temperature at 140 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 100 deg F.

e. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1) High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
2) Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
3) Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4) High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.

5) Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
6) Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
7) Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

f. Building Automation System Interface: Factory installed Modbus gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.

16. Electrical Power:

a. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
b. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

17. Source Quality Control:

a. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
b. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Boiler Vent System:

1. Vents shall be Saf-T Vent CI Plus as manufactured by HEATFAB, INC., SCHEBLER, JEREMIAS EXHAUST SYSTEM, Z-FLEX, SECURITY CHIMNEY, or approved equal.
2. All products furnished under this Section shall conform to the requirements of The National Fuel Gas Code, NFPA-54, where applicable and shall comply with and be listed to UL1738, Standard for Venting Systems for Gas-Burning Appliances, Category II, III and IV. Components coming in direct contact with products of combustion shall carry the appropriate UL listing mark or label.
3. The vent shall be of the double-wall, factory-built type for use on condensing appliances or pressurized venting systems serving Category II, III, or IV appliances or as specified by the equipment manufacturer. Maximum temperature shall not exceed 550°F (288°C).
4. Vent shall be listed for an internal static pressure of 6" w.g. and tested to 15" w.g.
5. Vent shall be constructed with an inner and outer wall, with a 1" annular insulating air space.
6. The inner wall (vent) shall be constructed of AL29-4C, superferritic stainless steel, .015" thickness for 6"-12" diameters and .024" thickness for 14"-24" diameters.
7. The outer wall (casing) shall be constructed of aluminized steel or 430 stainless steel, .018" thickness for 6"-12" diameters and .024" thickness for 14"-24" diameters.

8. Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of the inner and outer walls.
9. All vent parts exposed to the weather shall be stainless steel.
10. All supports, wall penetrations, terminations, appliance connectors and drain fittings, required to install the vent system shall be included.
11. Wall penetration pieces shall be UL listed and provided by the vent manufacturer.
12. All inner vent connections shall be secured by means of profiled connector bands with gear clamp tighteners. Joints shall be sealed with P077 Sealant.
13. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.
14. Vent shall terminate in accordance with installation instructions and local codes.
15. Clean all breechings of dust and debris prior to final connection to appliances.
16. Contractor shall pressure test the Breeching Systems as recommended by the manufacturer to demonstrate System integrity. Make necessary adjustments as required to meet the manufacturer's recommendations for System airtightness.

2.2 REFRIGERATION

A. Centrifugal Water-Cooled Chiller

1. Unit shall be size, type, and have capacity indicated on the drawings. YORK "YZ", DAIKIN "Magnitude", TRANE "Agility", or approved equal. Naming these products as equal does not imply that their standard construction or configuration is acceptable or meets the specifications. Equipment proposed "as equal", must meet the specifications including all mechanical, electrical, and structural details, all scheduled performance and the job design, drawings and specifications.

2. Submittals:

   a. Submittals shall include the following:

      1) Dimensioned plan and elevation view, including required clearances, and location of all field piping and electrical connections.
      2) Summaries of all auxiliary utility requirements such as: electricity, water, air, etc. Summary shall indicate quality and quantity of each required utility.
      3) Diagram of control system indicating points for field interface and field connection. Diagram shall fully depict field and factory wiring.
      4) Manufacturer's certified performance data at full load plus IPLV or NPLV.
      5) Installation and Operating Manuals.

3. Quality Assurance

   a. Chiller manufacturer plant shall be ISO certified and chiller shall be factory tested at manufacturer's plant prior to shipment.

4. Delivery and Handling

    a. Chiller shall be delivered to the job site completely assembled and charged with refrigerant and be shipped on skids with a weather resistant cover.

        1) Basis of Design Chiller uses refrigerant R-1233ZD(E). Other A2L classified refrigerants acceptable under the EPA's updated restrictions on HFC refrigerants effective January 1, 2024 are allowed.
        2) If a refrigerant other than R-1233ZD(E) is utilized, contractor shall coordinate to ensure refrigerant monitoring system and safety measures are properly selected and installed in accordance with requirements for the utilized refrigerant.

    b. Contractor shall comply with the manufacturer's instructions for rigging and transporting units and leave protective covers in place until installation.

5. Warranty

    a. Chiller shall be provided with 1-year entire unit parts and labor warranty. The chiller manufacturer's warranty shall cover parts and labor costs for the repair or replacement of defects in material or workmanship for a period of 1 year from equipment startup or 18 months from shipment, whichever occurs first.
    b. Manufacturer shall provide 1-year refrigerant warranty and 1-year extended warranty on compressor parts only.

6. Maintenance

    a. Maintenance of the chillers in accordance with manufacturer's recommendations as published in the installation and maintenance manuals shall be the responsibility of the owner.

7. Description

    a. Contractor shall provide and install as shown on the plans a factory assembled, charged, and tested water-cooled packaged centrifugal chiller. Chillers shall have no more than two oil-free, magnetic bearing, semi-hermetic centrifugal compressors (no exceptions). Each compressor shall have an integrated variable-frequency drive operating in concert with inlet guide vanes for optimized full and part load efficiency.
    b. On two-compressor units, the evaporator and condenser refrigerant sides and the expansion valve shall be common and the chiller shall be capable of running on one compressor with the other compressor or any of its auxiliaries inoperable or removed.

8. Design Requirements

   a. General:

      1) Provide a complete water-cooled, semi hermetic oil-free centrifugal compressor water chiller as specified herein.
      2) In general, unit shall consist of one or two magnetic bearing, completely oil-free centrifugal compressors, refrigerant, condenser and evaporator, and control systems including integrated variable frequency drive, operating controls and equipment protection controls.
      3) Chiller shall be charged with refrigerant R-1233ZD(E) or approved substitute A2L refrigerant.

   b. The entire chiller system, including all pressure vessels, shall remain above atmospheric pressure during all operating conditions and during shut down to ensure that non-condensables and moisture do not contaminate the refrigerant and chiller system. If any portion of the chiller system is below atmospheric pressure during either operation or shut down, the manufacturer shall include, at no charge:

      1) A 20-year purge maintenance agreement that provides parts, labor, and all preventative maintenance required by the manufacturer's operating and maintenance instructions.
      2) A complete purge system capable of removing non-condensables and moisture during operation and shut-down.
      3) The manufacturer shall also include at no charge for a period of 20 years an annual oil and refrigerant analysis report to identify chiller contamination due to vacuum leaks. If the analysis identifies water, acid, or other contaminant levels higher than specified by the manufacturer, the oil and/or refrigerant must be replaced or returned to the manufacturer's original specification at no cost to the owner.
      4) The manufacturer shall include a factory-installed and wired system that will enable service personnel to readily elevate the vessel pressure during shutdown to facilitate leak testing.

9. Compressors

   a. The unit shall utilize magnetic bearing, oil-free, semi-hermetic centrifugal compressors. The compressor drive train shall be capable of coming to a controlled, safe stop in the event of a power failure.
   b. The motor shall be of the semi-hermetic type, of sufficient size to efficiently fulfill compressor horsepower requirements. It shall be liquid refrigerant cooled with internal thermal sensing devices in the stator windings. The motor shall be designed for variable frequency drive operation.
   c. If the compressor design requires a shaft seal to contain the refrigerant, the manufacturer shall supply a 20 year parts and labor warranty on the shaft seal and a lifetime refrigerant replacement warranty if a seal failure leads to refrigerant loss, or the chiller manufacturer shall assume all costs to supply and install a self-

contained air conditioning system in the mechanical space sized to handle the maximum heat output of the open drive motor. The energy required to operate this air conditioning system shall be added to the chiller power at all rating points for energy evaluation purposes.

d. If the compressor/motor uses any form of antifriction bearing (roller, ball, etc.), the chiller manufacturer shall provide the following at no additional charge:

   1) A 20-year bearing warranty and all preventative maintenance as specified by the manufacturer's published maintenance instructions.
   2) At start up, a three-axis vibration analysis and written report to establish bearing condition baseline.
   3) An annual three-axis vibration analysis and written report indicating bearing condition.

e. The chiller shall be equipped with a refrigerant cooled and integrated Variable Frequency Drive (VFD) to automatically regulate compressor speed in response to cooling load and the compressor pressure lift requirement. If a condenser water-cooled VFD is supplied, the manufacturer shall supply factory installed dual water filters with a bypass valve and pressure differential switch factory wired to the chiller control panel to indicate that a filter has clogged and requires service. The pressure differential switch shall also provide a separate dry contact which can be connected to the BAS system as a means of notifying operating personnel of the need to service the filters. If the condenser cooling circuit includes an intermediate heat exchanger, it must be of the brush cleanable shell and tube style. Brazed plate heat exchangers which cannot be field cleaned are not acceptable. Movable inlet guide vanes and variable compressor speed shall provide unloading. The chiller controls shall coordinate compressor speed and guide vane position to optimize chiller efficiency.

f. Each compressor circuit shall be equipped with a 5% line reactor to help protect against incoming power surges and help reduce harmonic distortion.

10. Evaporator and Condenser

a. The evaporator and condenser shall be separate vessels of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure, but not less than 100 psig. The tubes shall be individually replaceable and secured to the intermediate supports without rolling or expanding to facilitate replacement if required.

b. The evaporator shall be flooded type with copper tubes rolled into carbon steel tubesheets. The evaporator shall have right-hand connections when looking at the unit control panel. The evaporator shall have dished heads with valved drain and vent connections. Water connections shall be grooved suitable for Victaulic couplings. The heads shall be carbon steel and the tubesheets shall be carbon

steel. The waterside shall be designed for a minimum of 150psig. The wall copper tubes shall be 0.025 in.

c. The condenser shall have tubes rolled into carbon steel. The condenser shall have right-hand connections when looking at the unit control panel. The condenser shall have dished heads with valved drain and vent connections. The waterside shall be designed for a minimum of 150psig. Water connections shall be grooved suitable for Victaulic couplings. The heads shall be carbon steel and the tubesheets shall be carbon steel. The wall copper tubes shall be 0.025 in.

d. An electronic expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions. The liquid line shall have moisture indicating sight glass.

e. Provide sufficient isolation valves and condenser volume to hold the full unit refrigerant charge in the condenser during servicing or provide a separate pump out system and storage tank sufficient to hold the charge of the largest unit being furnished.

f. Re-seating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one relief valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the condenser. Rupture disks are not acceptable. If rupture disks are required on negative pressure units to prevent air and moisture ingress, then factory mounted spring-loaded pressure relief valves shall be provided in series with the rupture disks to contain the remaining refrigerant in the event of vessel over-pressurization. The space between the rupture disk and the relief valve shall include a suitable telltale indicator integrated into the chiller control system to alert the operator that a potential safety issue exists in the pressure relief system.

g. The evaporator vessel, including water heads, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with UL recognized ¾ inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.

h. Provide factory-mounted and wired, thermal-dispersion water flow switches on each vessel to prevent unit operation with no or low water flow. Paddle and pressure differential type switches are not acceptable due to high rates of failure and false indications from these types of flow indicators.

11. Vibration Isolators

    a. Provide neoprene waffle-type vibration isolators for each corner of the unit.

12. Power Connection

    a. The power connection shall be single point with non-metal compressor conduits and disconnect switch.

13. Controls:

    a. The unit shall have a microprocessor-based control system consisting of a 15-inch VGA touch-screen operator interface and a unit controller.

    b. The touch-screen shall display the unit operating parameters, accept setpoint changes (multi-level password protected) and be capable of resetting faults and alarms. The following parameters shall be displayed on the home screen and also as trend curves on the trend screen:

        1) Entering and leaving chilled water temperatures
        2) Entering and leaving condenser water temperatures
        3) Evaporator saturated refrigerant pressure
        4) Condenser saturated refrigerant pressure
        5) Percent of 100% speed (per compressor)
        6) % of rated load amps for entire unit

    c. In addition to the trended items above, all other important real-time operating parameters shall also be shown on the touch-screen. These items shall be displayed on a chiller graphic showing each component. At a minimum, the following critical areas must be monitored:

        1) Compressor actual speed, maximum speed, percent speed
        2) Liquid line temperature
        3) Chilled water setpoint
        4) Compressor and unit state and input and output digital and analog values

    d. A fault history shall be displayed using an easy to decipher, color coded set of messages that are date and time stamped. Time interval scale shall be user selectable as 20 mins, 2 hours, or 8 hours. The alarm history shall be downloadable from the unit's USB port. An operating and maintenance manual specific for the unit shall be viewable on the screen.

    e. All setpoints shall be viewable and changeable (multi-level password protected) on the touch screen and include setpoint description and range of set values.

    f. Automatic corrective action to reduce unnecessary cycling shall be accomplished through preemptive control of low evaporator or high discharge pressure conditions to keep the unit operating through abnormal transient conditions.

    g. The chiller shall be capable of automatic control of: evaporator and condenser pumps (primary and standby), up to 3 stages of cooling tower fan cycling control and a tower modulating bypass valve or cooling tower fan variable frequency drive.

    h. The factory mounted controller(s) shall support operation on a network via BACnet® w/RS485 and Ethernet as specified by the successful Building Automation System (BAS) supplier.

    i. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.

j. All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

14. Optional Items

a. The following optional items shall be furnished:

1) Shipping Bag w/ no Standard Wood Skidding
2) Pump-out unit, with or without storage vessel
3) Refrigerant monitor
4) To ensure quick and trouble free start up and commissioning, the chiller shall pass a full battery of factory tests. These tests will include the verification of operating and compressor controls to ensure full unit functionality and manufacturing integrity. Any deviation from stringent factory quality standards shall be remedied prior to shipment.
5) Certifications: ETL/CETL Approval. Certified to AHRI 550/590. Meets ASHRAE 90.1 2010 Standard
6) Harmonic filter(s) to work in conjunction with the line reactor to further minimize harmonic distortion

15. Installation and Startup

a. Installing contractor shall:

1) Install per manufacturer's requirements, shop drawings, and contract documents.
2) Adjust chiller alignment on foundations, or subbases as called for on drawings.
3) Arrange piping to allow for dismantling to permit head removal and tube cleaning.
4) Coordinate electrical installation with electrical contractor.
5) Coordinate controls with control contractor.
6) Provide all material required for a fully operational and functional chiller.

b. Manufacturer shall provide factory start-up services for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full working days. During the period of start-up, the start-up technician shall instruct the owner's representative in proper care and operation of the unit.

2.3 AIR HANDLING EQUIPMENT

A. Exhaust Fans:

1. Fans shall be size, type, and have capacity as indicated on drawings. GREENHECK, LOREN COOK, PENNBARRY ,or approved equal.
2. Fans shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. Fan air performance ratings shall be based on tests conducted in an AMCA registered laboratory for AMCA 210 air performance testing. The Test Standard used shall be ANSI/AMCA Standard 210-85, ANSI/ASHRAE Standard 51-1985, "Laboratory Methods of Testing Fans for Rating." All sizes must be tested, calculations to other sizes not acceptable. Fan sound performance shall be based on tests conducted in an AMCA registered laboratory for AMCA 300 Sound Performance Testing. The Test Standard used shall be AMCA 300 "Reverberant Room Method for Sound Testing of Fans." All sizes must be tested, calculations to other sizes are not acceptable. Air or Sound Test results are to be included in submittal.
3. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
4. Provide solid-state speed controls or electronically commutated motors for all direct drive fans.
5. All fans shall be statically and dynamically balanced.
6. Install as required for quiet operation.
7. Motor shall be a DC electronic commutation type motor (ECM) specifically designed for fan applications unless otherwise noted.

8. Downblast power roof ventilators:

    a. Downblast power roof ventilators shall have aluminum housing, backward-inclined aluminum fan wheel, gravity-type back-draft dampers, bird screen, aluminum curb cap with pre-punched mounting holes, aluminum rub ring, motor isolated shock mounts, corrosion-resistant fasteners, lifting lugs and factory-wired NEMA 1 toggle disconnect switch. Provide direct drive as indicated. Shaft shall be mounted in ball bearing pillow blocks. Bearings shall have grease fittings.

9. Inline Exhaust Fans:

    a. Cabinet in-line type shall have forward curved centrifugal fan wheel, and galvanized fan housing and factory-wired disconnect switch. Provide vibration isolators as specified in paragraph 2.8.
    b. The fan housing shall be of the square design, constructed of heavy gauge galvanized steel and shall include duct mounting collars.
    c. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be sufficient size to permit easy access to all interior components.
    d. Motors shall be permanently lubricated and carefully matched to the fan loads. Motors shall be readily accessible for maintenance.
    e. Inline fans shall be suitable for vertical or horizontal flow orientation.

10. Kitchen Hood Exhaust Fan:

    a. Fan shall be size, type, and have capacity as indicated on drawings. GREEHNECK, LOREN COOK, ACME, PENNBARRY, or approved equal.
    b. Kitchen hood roof exhaust fans shall be upblast centrifugal belt driven type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. Windbands shall have a rolled bead for added strength and shall be joined to curb caps with a leakproof, continuously welded seam.
    c. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
    d. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
    e. Motor pulleys shall be adjustable for final system balancing. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.
    f. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
    g. The fan shall be UL 762 listed for grease removal.
    h. Fan shall be mounted on existing curbs. Where dimensions of fan bases do not match curb dimensions provide galvanized steel adapters. Provide curb extension if required to meet minimum discharge height of 40 inches.

11. Kitchen Hood Supply Fan:

    a. Fan shall be size, type and have capacity as indicated on drawings. GREENHECK, LOREN COOK, ACME or approved equal.
    b. Roof mounted, filtered, make-up air units shall be of the belt-driven, double width/double inlet, forward curved, centrifugal blower type.
    c. The hood shall be constructed of heavy gauge galvanized steel and adequately sized to prevent rain and snow from entering the building. The cover shall be constructed of heavy gauge galvanized steel, removable for service.
    d. Hood bases shall have pre-punched mounting holes.
    e. Permanent washable 1 in aluminum filters shall be provided.
    f. Fan wheels shall be of the forward curved type, constructed of heavy gauge steel and statically and dynamically balanced to ensure smooth, vibration free operation.

g. Motors shall be permanently lubricated, heavy duty, ball bearing type carefully matched to the fan load and furnished at the specified voltage, phase and enclosure
h. The fan shaft shall be ground and polished steel mounted in heavy duty, sealed ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speeds. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor sheaves shall be adjustable for final system balancing. Drives shall be sized for a minimum of 150% of driven horsepower. The entire fan and motor assembly shall be mounted on vibration isolators to prevent noise transmission.
i. The make-up air units shall bear the AMCA Certified Ratings Seal for air and sound performance.
j. Fan shall be mounted on existing curbs. Where dimensions of fan bases do not match curb dimensions provide galvanized steel adapters.

B. Replacement parts for Air Handling Units:

1. Supply Fans:

a. Where existing supply fans are Vertical Centrifugal Barry Blowers, provide mixed flow belt drive power ventilator, GREENHECK model “QEI” or approved equal.

1) Wheels shall be of welded construction with single thickness cambered blades.
2) Fan housing shall be continuously welded steel with welded steel air straightening vanes.
3) Fan assemblies shall have motor and V-belt drives, mounted on existing spring isolators with new flexible connection between fan and fan wall.
4) The fan wheel bearings shall be heavy-duty, grease-lubricated, anti-friction ball or roller, self-aligning type, with extended lubrication lines and selected for a minimum average bearing life (AFBMA L-10) in excess of 120,000 hours at the maximum class RPM.

b. All other supply fans shall be of the centrifugal, plenum type with securely welded, die-formed backward curved (16” and smaller) or airfoil (18” and larger) type by GREENHECK, LOREN COOK, PENNBARRY, or approved equal.

1) Fan assemblies shall have adjustable motor bases, motor and V-belt drives, mounted with the assembly mounted on existing spring isolators with new flexible connection between fan and fan wall.
2) The fan wheel bearings shall be heavy-duty, grease-lubricated, anti-friction ball or roller, self-aligning, pillow-block type, and selected for a minimum average bearing life (AFBMA L-50) in excess of 200,000 hours at the maximum class RPM.

c. Fan wheels shall be statically and dynamically balanced.

d. The fan shaft shall be polished steel, accurately turned, ground, and ring gauged for accuracy. Shafts shall be sized for first critical speed of at least 1.25 times the maximum speed for the class.
e. Supply fan shall be installed on existing vibration isolation springs and steel base rail with punched inlet and outlet flanges.
f. Provide new flexible connection between fan and unit supply air discharge section.
g. Fan ratings shall be based on tests made in accordance with AMCA Standard 210 and shall bear the AMCA Seal.

2. Exhaust Fans:

a. Exhaust fans shall be centrifugal airfoil plenum type fans as manufactured by GREENHECK, LOREN COOK, PENNBARRY, or approved equal.
b. Fans shall be statically and dynamically balanced.
c. Fan assemblies shall have adjustable motor bases, motor and V-belt drives, mounted with the assembly mounted on existing spring isolators with new flexible connection between fan and fan wall.
d. The fan wheel bearings shall be heavy-duty, grease-lubricated, anti-friction ball or roller, self-aligning, pillow-block type, and selected for a minimum average bearing life (AFBMA L-50) in excess of 200,000 hours at the maximum class RPM.
e. The fan shaft shall be polished steel, accurately turned, ground, and ring gauged for accuracy. Shafts shall be sized for first critical speed of at least 1.25 times the maximum speed for the class.
f. Exhaust fans shall be installed on existing vibration isolation springs and steel base rails.
g. Provide new flexible connection between fan and unit exhaust plenum section.
h. Fan ratings shall be based on tests made in accordance with AMCA Standard 210 and shall bear the AMCA Seal.

3. Variable Speed Control:

a. New Variable Frequency Drives (VFDs) shall be provided for all fan sections.
b. Refer to VFD requirements in section 2.9 of this specification.

4. Filters:

a. Filters shall be FARR type 30/30. Air filters shall be 2” thick, pleated, disposable type. Each filter shall consist of a nonwoven cotton and synthetic fabric media, media support grid, and enclosing frame.
b. The filter media shall have an average efficiency of 25-30% on ASHRAE Test Standard. The filter is listed by a UL Class 2.
c. A bank of galvanized universal holding frames shall be arranged for upstream access.
d. Provisions shall be made on the downstream side of the frames to prevent filter blowout from moisture or overloading.

e. Outside air, high-efficiency filters shall be mounted in the same filter bank with the pre-filters, shall be 12” deep, high-performance filters, deep pleated, totally rigid and consisting of high-density media, media support grid, contour stabilizers, diagonal support bracing, and enclosure frame. The media shall have an average efficiency of 65%. The filter shall be listed by UL as Class 2.

5. Chilled and Hot Water Control Valves:

a. Control valves shall be provided by the Automatic Temperature Control Contractor and installed by the Mechanical Contractor.

6. Coils:

a. Coils shall be 1/2" O.D. as manufactured by JOHNSON CONTROLS, or approved equal sized to fit in existing unit cabinet and meet scheduled performance requirements. Coils shall be tube and corrugated fin construction with aluminum fins and galvanized steel casing.
b. Fins constructed of aluminum shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing.
c. Coils shall be proof-tested to one and one-half times the maximum working pressure, and leak tested at maximum working pressure. Test shall be performed air-under-water.
d. Coil performance data shall be certified in accordance with ARI Standard 410.
e. Headers shall be inside the air handling unit. Provide auxiliary drain pan complete with ½" MPT drain connection at headered end of cooling coils. The non headered end of the coil shall be fully concealed.
f. Coil shall be removable from the unit at the headered end, unless shown otherwise on the drawings.
g. Access between coils and major components shall be no less than 24 inches.

2.4 UNITARY EQUIPMENT (NOT USED)

2.5 TERMINAL EQUIPMENT

A. Cabinet Unit Heaters:

1. Units shall be size, type, and have capacity indicated. AIRDALE, TRANE CO., MCQUAY, or approved equal.
2. Units shall be complete, including casing, copper-tube/aluminum-fin heating coils, fans, fan motor, built-in disconnect switch, filters, and baked-enamel cover in color selected by Engineer/Owner.
3. Motors shall be multi-speed, permanent-split-capacitor type with built-in overload protection.
4. Filters shall be 1” thick, throwaway type.
5. Controls shall be provided under section 230900.

B. Hot Water Duct Heating Coils:

1. Provide duct heating coil as manufactured by JOHNSON CONTROLS, TRANE, YORK, or approved equal.
2. General: Coil shall be designed with aluminum plate fins and copper tubes. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. Coil shall have airflow arrow and nameplate attached to coil casing. Capacities, pressure drops, and selection procedures shall be certified in accordance with ARI Standard 410.
3. Hot Water Coil: A double-row serpentine coil, with 1/2" OD tubes. Coil shall have a supply header to ensure distribution of hot water to each tube of coil. Coil shall be proof tested at a minimum of 300 psig and leak tested to 200 psig air pressure under water. Working pressure shall be 200 psig at 220°F.
4. Coil Casing: coil casing shall be manufactured with galvanized steel.
5. Water Coil Tubes: Tubes shall be 12" OD, .016" thick copper tubes.

2.6 HVAC PIPING AND SPECIALTIES

A. PIPING

1. Water, refrigerant, and HVAC drain piping shall be provided as specified below. Where options of different materials are given for the same service, contractor shall select materials and use them uniformly throughout the system. Contractor shall submit experience with all of the materials and joining methods specified.

2. Chilled, Hot and Condenser water piping:

a. Above ground

1) Schedule 40 black steel (2 inch and under)
2) Schedule 40 black steel (2-1/2 inch and over)

b. Threaded Steel Piping

1) Schedule 40 black steel

3. Gas Piping:

a. Within Building:

1) Schedule 40 black steel – screw fabricated (2 inch and under)
2) Schedule 40 black steel – welded (2-1/2 inch and over)

b. Exterior to Building:

1) Galvanized steel – screw fabricated (2 inch and under)
2) Galvanized steel – welded (2-1/2 inch and over)

4. Drain piping in mechanical equipment rooms:

    a. Above ground

        1) Type L copper

5. Type L copper pipe shall conform to ASTM B42, and be assembled with wrought-copper soldering fittings using 95-5 solder or with press on fittings as specified herein.
6. Schedule 40 PVC pipe shall be assembled in strict accordance with manufacturer's instructions. Solvent cement shall conform to ASTM D2564.
7. Schedule 40 black steel pipe shall be fabricated by welding using Schedule 40 steel welding fittings conforming to ASTM A53.
8. Grooved piping shall not be used.

9. Press on Connector Fittings

    a. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and NSF/ANSI Standard (NSF 61). Sealing elements for press fittings shall be factory installed EPDM.
    b. Press–connected fittings 1/2" – 2" press end shall have a leak-before-press feature, which assures leakage from inside the system past the sealing element of an unpressed connection. Fittings 2-1/2" – 4" press end shall have a factory installed means for visual inspection of completed press.
    c. Copper press fitting joints shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tuning marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark in the tubing to ensure the tubing is fully inserted in the fitting. The joints shall be pressed using the pressing tool and jaws or jaw set, approved by the fitting manufacturer.
    d. Fitting installer shall be trained by the fitting manufacturer's factory representative.
    e. Press connected fittings shall be by ELKHART PRODUCTS CORP., NIBCO, VIEGA or approved equal.

10. Piping shall be run concealed, except where no ceiling is provided. Coordinate installation of piping with other disciplines. Locate all piping tight against structure where possible. No piping shall be installed below mechanical equipment, or within mechanical or electrical equipment clearance requirements.
11. Pitch hydronic piping to vent at high points and provide accessible drains at low points.
12. All concealed condensate drain piping shall be labeled at its termination point to indicate whether the drain piping is connected to a primary or secondary (auxiliary) mechanical unit drain.

B. Valves:

1. Valves 2" size and under shall be bronze with soldered ends, rough bodies, and finish trim. Valves 2-1/2" size and over shall be iron-body, bronze-mounted with flanged ends,

except where specifically indicated. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Catalog numbers indicated below are NIBCO. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.

Size	**Pipe Material**	**Globe**	**Check**	**Ball/Butterfly**
2" and under	Copper	S-235-Y	S-413-W	S-585-70-66NS
2-1/2" and over	Copper	F718-B	F918-B	LD-2000
2-1/2" and over	Steel	F718-B	F918-B	LD-2000

2. In lieu of gate valves, the contractor may provide “Bray Series 3L” butterfly valves, NO SUBSTITUTIONS, where shown for isolation of mechanical systems and equipment. The valves shall be provided with double u-cup stem seal, molded seat flat primary and secondary seals and flanged connections.
3. Check valves in pump discharge lines shall be NIBCO F-910 “silent check valve”. Valves with equivalent characteristics by APOLLO, METRAFLEX, or MILWAUKEE are acceptable.
4. Balancing valves 2" and smaller shall be NIBCO S-585-70-66NS. Balancing valves 2-1/2" and larger shall be butterfly valves as specified below. Valves shall be complete with memory stops. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.
5. Butterfly valves used for balancing purposes shall be ductile iron, lug type and suitable for dead-end service, 200 psig, bubble-tight shutoff, and 250°F service. Disc shall be aluminum bronze with 416 stainless-steel extended shaft and copper or brass bushings. Seat shall be EPDM. Provide lever actuators with ten positions with memory stops. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. NIBCO LD-2000, or approved equal. Valves 6" and above shall be provided with gear operators. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.

6. Pressure Relief Valves:

    a. Provide ASME-rated bronze body, direct spring-loaded, diaphragm-type, lever-operated relief valve with factory-set discharge pressure. Valve body shall have threaded connections and be designed for a working pressure of 150 psi. Fluid shall not discharge into spring chamber.
    b. Provide relief valves on low pressure side of pressure reducing valves where indicated.
    c. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity.

C. Y-Strainers:

1. Strainers shall be self-cleaning “Y” type, of same size as pipe in which it is installed.

2. Provide valved blow-off outlet with hose connection and cap on each strainer. Blow-off connections shall be at bottom of strainer and shall be of size equal to 1/2 the pipe up to a maximum of 2".
3. Screen perforations shall be suitable for intended service. Provide micron screen for flushing of system.

D. Base Mounted End Suction Circulating Pumps:

1. Pumps shall be size, type, have capacity and arrangement as indicated, designed for service encountered. Basis of design shall be BELL & GOSSETT. Acceptable alternates include ARMSTRONG and TACO.

2. End suction pumps shall be bronze fitted, cast-iron case. Pumps shall be base-mounted, single stage, end suction design.

    a. Pump volute shall be made of cast iron with integrally cast pedestal support. The impeller shall be cast bronze, enclosed type, statically and hydraulically balanced. Impeller shall be keyed to the shaft and secured by a hex head impeller nut and washer.
    b. Pumps shall be provided with a single inside unbalanced mechanical shaft seal for leakless operation. A suitable arrangement shall be provided to furnish a portion of the pumped liquid to lubricate and cool the seal faces.
    c. Pump shall be rated for a minimum of 175 psi working pressure. Casings shall be provided with tapped and plugged holes for priming, vent, and drain.
    d. Pump bearing housing shall have heavy duty re-greaseable ball bearings.
    e. Baseplate shall be channel steel, sufficiently rigid to support the pump and driving motor.
    f. A flexible-type coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor, and it shall be equipped with a suitable coupling guard as required. Contractor to level and grout each unit according to manufacturer’s instructions.
    g. The motor shall be NEMA specifications and shall be the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by contractor after installation.
    h. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.
    i. Each pump shall be checked by the contractor and regulated for proper differential pressure, voltage and amperage draw. This data shall be noted on a permanent tag or label and fastened to the pump for owner’s reference.

3. Pumps shall be non-overloading over entire impeller curve within service factor of motor. Pumps shall be sized for a maximum discharge velocity of 16 FPS and a maximum suction velocity of 12 FPS.
4. Provide suction diffusers matched to pump and system piping for end suction pumps.
5. Provide Aegis Shaft Grounding Rings on all pump shafts to extend the life of the bearings.

E. Suction Diffusers:

1. Contractor shall furnish and install a suction diffuser on the suction side of pumps as indicated on the drawings. Suction diffuser shall be as manufactured by Bell & Gossett or approved equal. Suction diffusers shall meet sizes and characteristics as specified in the following and as scheduled.
2. Units shall consist of an angle type body with internal straightening vanes that run the full length of the diffuser and a combination diffuser/strainer/orifice cylinder with 3/16" diameter openings for pump protection. The orifice cylinder shall be equipped with a disposable bronze fine 16-mesh strainer, which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross section area of pump suction opening. Vane length shall be no less than 2 1/2 times the pump connection diameter. Unit shall be provided with a connection point where a field fabricated support foot can be attached to carry weight of suction piping.
3. Diffuser manufacturer shall be responsible for any reduction in pump performance or damage due to high pressure drops, internal failures of components or harmonic oscillations caused by the diffuser.

F. Flexible Pipe Connectors:

1. Furnish and install braided stainless-steel flexible metal pipe connectors as manufactured by MASON-MERCER, FLEX-HOSE CO., INC., or approved equal. Construction to be of annular corrugated close pitch hose of stainless steel with stainless-steel braid. End fittings shall be 150# plate steel flanges. Install per FLEX-HOSE recommendations in Bulletin PC 88/4. Connectors shall be a minimum of 24" long.

G. Pressurized Expansion Tanks:

1. Tanks shall be ASME Code construction for 125 psi service, of sizes indicated. Tanks shall be pre-charged bladder type. BELL & GOSSETT Series “B-LA,” or equal by TACO.

    a. Expansion tanks are ASME rated pre-charged bladder-type pressure vessels designed to absorb the expansion forces of heating/cooling system water while maintaining proper system pressurization under varying operating conditions.
    b. Tank shall have a heavy-duty bladder to contain system water to prevent tank corrosion and water logging problems.
    c. Maximum working pressure shall be 125 PSI and maximum operating temperature shall be 240ºF.
    d. System connections shall be forged steel. Tank shell shall be carbon steel.
    e. Bladder shall be heavy duty butyl rubber.
    f. Tank shall be designed and constructed per ASME Section VIII, Division.
    g. Tanks shall be complete with system and drain connections, air charging valve connection, and lifting ring.
    h. Volume of tank indicated is acceptance volume.

H. Pressure Relief and Reducing Valves:

1. Provide relief and reducing valves with fast fill feature. Construction shall be cast iron with brass seats and brass strainer. BELL & GOSSETT, or approved equal.

I. Air Eliminator and Dirt Separator:

1. Furnish and install a coalescing type air eliminator and dirt separator on the chilled water system, SPIROVENT Model VDN or equal. All combination units shall be fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM.
2. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle must consist of a copper core tube with continuous wound copper medium permanently affixed to the core.
3. A separate copper medium is to be wound completely around and permanently affixed to the internal element. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation.
4. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
5. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
6. Separator shall have the vessel extended below the pipe connections an equal distance for dirt separation.
7. Air Eliminators shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid. Dirt separation shall be at least 80% of all particles 30 micron and larger within 100 passes.
8. Separator shall include a removable flanged lower head to facilitate removal of assembly for inspection or cleaning.

J. Air Vents:

1. Provide manual air vents where indicated, and where required to properly and adequately vent heating system of air. Vent shall utilize a ball valve with handle in lieu of key operated.
2. Provide automatic air vents where indicated (in Mechanical Room only.) BELL & GOSSETT Model 107, or approved equal.

K. Thermometers:

1. Thermometers shall be provided as indicated. WEKSLER INSTRUMENT, Type “AF.”
2. Thermometers in pipelines shall be separable socket 5" dial bi-metal insertion type, with scale suitable for temperature range of medium being measured. Thermometers shall be located to facilitate reading from floor. Angle-type shall be used where necessary to facilitate reading. Install in thermal well in flow of fluid.
3. Thermometer range shall be 0-150°F for chilled water and 30-240°F for hot water.

L. Pressure Gauges:

1. Pressure gauges shall be provided on suction and discharge line of each pump and where indicated. WEKSLER INSTRUMENT, model aa-14-2.
2. Thermometers in pipelines shall be separable socket 5" dial bi-metal insertion type, with scale suitable for temperature range of medium being measured. Thermometers shall be located to facilitate reading from floor. Angle-type shall be used where necessary to facilitate reading. Install in thermal well in flow of fluid.
3. Thermometer range shall be 0-150°F for chilled water and 30-240°F for hot water.

M. Automatic Balancing Valves:

1. Provide NuTech Model AB, or approved equal, measuring and balancing valves where indicated for pipe sizes 1/2" to 12".
2. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5% of the specified amount.
3. For 1/2" - 2", the flow cartridge shall be removable from the Y-body housing without the use of special tools to provide access for cartridge change out, inspection, and cleaning without breaking the main piping. (Access shall be similar to that provided for removal of a Y-strainer screen).
4. True operating range of 2 - 32 psid required. The design flow should be achieved at the minimum psi differential. A 50% safety factor applied to the lower operating range is not acceptable.
5. Each valve shall have two P/T ports.
6. All automatic flow control devices shall be supplied by a single source.
7. Five-year product warranty and free first year cartridge exchange.
8. The internal wear surfaces of the valve cartridge must be Ultrason® composite or stainless steel.
9. The flow cartridge design shall incorporate a stainless steel spring which requires no adjustment screw or shims. A crimped sheet-metal design is not acceptable.
10. The internal flow cartridge shall be permanently marked with the GPM.
11. For 1/2" through 2" pipe sizes: The valve shall consist of a brass Y-type body, O-ring-type union, and integral brass body ball valve with memory stop. The ball valve ID shall be minimum standard port (one size smaller than valve connection size). **Reduced port valves are not acceptable**. NuTech Model AB, or approved equal.
12. For 2-1/2" and larger flanged connections: Ductile-iron body suitable for mounting wafer style between standard 150# or 300# flanges. The long flange bolts and nuts shall be provided with each automatic flow control valve. NuTech Model AW or approved equal.
13. All valves shall be factory leak tested at 100 psi air under water. Provide Certificate of Conformance indicating that the valve passed pressure test with no leaks.

14. Ratings:

a.	1/2” through 2” pipe size:	600 psig at 250°F
b.	2-1/2” through 12” pipe size:	600 psig at 250°F

15. Where indicated on the plans, the differential pressure across the automatic flow control valve shall be measured for flow verification and to determine the amount of system

over-heading or under-pumping. Where over-heading exist the ball valve shall be throttled to bring the flow cartridge back within the control range. The valve memory stop shall be set so the valve can be used for isolation and reopened to the balanced position.

16. The flow shall be verified by measuring the differential pressure across the coil served or the wide-open temperature control valve and calculating the flow using the coil or valve $C_{v.}$
17. A differential pressure test kit shall be supplied to verify flow and measure over-heading. The kit shall consist of a 4-1/2" diaphragm gauge equipped with 10-foot hoses and P/T adapters, all housed in a vinyl case. Calibration shall be 0-35 PSID for 2-32 PSI spring range or 0-65 PSID for 5-60 PSI range.
18. Install automatic flow control valves on the return lines of coils as indicated on the plans. Balancing valve on supply side is not acceptable. Submit proposed piping arrangement for approval by the Engineer.
19. The standard ports and handles shall clear 1" thick insulation. Handle and port extensions are required for over 1" thick insulation.
20. Install, on the supply side of coils, a Y-strainer with a brass blow-down valve with 3/4" hose end connection with cap and chain.

N. Flow Stations:

1. Provide Venturi flow meter and butterfly balancing valve as indicated. NUTECH Model MF, or approved equal.
2. Flow meter sizes 2-1/2" thru 6” shall be constructed of cast carbon-steel ASTM A120 with accurately machined throat. Sizes 8" and larger shall be fabricated carbon-steel with carbon steel insert. Provide 150-pound ANSI B16.5 flanged connections. Meter shall be rated at 200 psig at 250°F. Provide brass needle valves 1/4" SAE M with 2.5" brass extension. Low loss venturi shall have a measurement accuracy of 3%.
3. Butterfly valve shall be constructed of ductile-iron, lug-type body, ANSI Class 125/150, with EPDM seat and gasket, 416 stainless-steel stem, Teflon bushing and aluminum/bronze disk. The butterfly valve shall have a 2" extended neck above the flange to accommodate insulation thickness. The valve handle shall have infinite flow positioning plate which allows the valve to be closed without the need of unlocking the valve handle or losing the balancing position on valve sizes 2-1/2" thru 6". Gear operator shall be supplied on valves sizes 8" and larger.
4. The entire assembly shall have been matched and laboratory tested for accuracy and shall have a 5-year warranty.
5. Total pressure drop shall not exceed one foot.
6. Flow rate increments shall be suitable for the indicated flow rate.

O. Test Stations – Pressure/Temperature (P/T):

1. Install a 1/4" NPT fitting (Test Plug) of solid brass with brass chain at indicated locations. Test plug shall be capable of receiving either a pressure or temperature probe 1/8" o.d. Dual seal core shall be neoprene for temperature to 200°F and shall be rated zero leakage from vacuum to 1,000 psig. PETERSON EQUIPMENT COMPANY, SISCO, or approved equal.

2. One Master Test Kit shall be provided to the Owner. Kit shall contain one 2-1/2" pressure gage of suitable range, one Gage Adapter 1/8" o.d. probe, and one 5" stem pocket testing thermometer 0° to 220°F.

2.7 AIR DISTRIBUTION

A. Ductwork

1. Provide all ducts, plenums, connections, dampers, and related items required to form a complete system as indicated on drawings and specified herein.
2. All ductwork shall be sheet metal.
3. Sheet-metal ducts shall be fabricated from G60 galvanized-steel sheets, 304 stainless steel, or 3003 aluminum, and shall be of gauges called for and as detailed in 2005 SMACNA Manual, HVAC Duct Construction Standards (Metal and Flexible). All ductwork from variable air volume air handlers to the inlet of VAV terminal boxes shall be 3" w.g. pressure class construction and shall be double-wall round. All constant volume ductwork shall be 1" w.g. pressure class construction and shall be single-wall rectangular or round.
4. Duct sealing requirements shall be Class A for all ductwork.
5. Round and flat oval duct and fittings shall be manufactured by a company for whom the manufacture of spiral duct and welded fittings has been a principal business for at least 15 years. Contractor fabricated round and flat oval spiral duct and fittings will not be acceptable.

6. All companies being considered as potential suppliers of duct and fitting components shall submit drawings and dimension data for approval. These submittals will serve as a basis for acceptance or rejection of product.

    a. All fittings furnished for use on a project must be identical to the approved submittal data.
    b. Any fittings rejected by the project engineer shall be replaced with fittings equal to the original approved submittals. All expenses incurred in the replacement of fittings that do not conform to these requirements shall be the responsibility of the installing contractor.

7. All medium pressure supply duct shall be of round spiral lockseam construction where indicated. Steel round duct shall be of standard spiral with 2C corrugations for all duct greater than 14" diameter (without intermediate ribs) or single-rib construction and shall be provided with gauges according to the following 2005 SMACNA HVAC DCS, except no 28 gauge material is allowed:

Diameter	Standard Spiral Gauge		Single-Rib Spiral Gauge
(inches)	0-2" w.g.	2-10" w.g.	0-10" w.g. .
3-8	28	26	--
9-14	28	26	28
15-26	26	24	28
27-36	24	22	28

8. Duct shall be provided in continuous, un-joined lengths wherever possible. Except when interrupted by fittings, round spiral duct sections shall not be less than 12 feet long. Round spiral pipe and fittings greater than 24" diameter, and oval spiral pipe and fittings greater than 25" wide, will have flanged connections. Flanges for dual wall duct must also hold the inner liner of dual wall duct concentric without the use of additional couplings or spacers.
9. Round ductwork for exposed application shall be in accordance with SMACNA 2005 standards for low pressure duct application. Duct shall be double-wall, spiral, lockseam construction. Where rectangular take-offs for registers are shown, a tack-welded factory-installed take-off shall be provided. Exposed duct shall have "paint grip" finish suitable for field painting. Exposed ductwork shall be "Architectural" grade and shall receive special care in construction and shipping.
10. Double-wall round ductwork shall be used where indicated, and shall be of spiral lockseam construction with an airtight outer pressure shell, a 2" thick insulation layer, and a solid inner liner that completely covers the insulation throughout. Fittings to have solid inner liner.

11. Unless otherwise specified, all double-wall duct and fittings inner shell for dual wall duct shall be a minimum G-60 galvanized sheet metal. All spiral pipe used for inner shells will have 3 intermediate ribs and be fabricated in accordance with ASTM A525 and A527 specifications in the following minimum gauges:

Nominal Duct Size	Inner/Outer Shell (Gauge)	Inner Shell (Gauge) .
3-24	26	26
25-34	24	26
35-42	22	26

12. Fittings shall be of the following minimum gauges:

Nominal Duct Size	Inner/Outer Shell (Gauge)	Inner Shell (Gauge)
3-34	22	24
35-48	20	22

13. Round fittings may be spot welded and bonded. Oval fittings shall be continuously welded.

14. Insulation shall have the following UL rating:

Flame Spread	10-20
Fuel Contributed	10-15
Smoke Developed	0-20

15. Round and flat oval spiral duct and fittings shall be UNITED MCGILL CORPORATION, or equal by HAMLIN SHEET METAL, SEMCO MANUFACTURING, LINDAB, INC or EASTERN SHEET METAL.

16. Round and flat-oval ductwork and fittings shall not be delivered to the job site until just prior to erection. Ductwork with dents or other damages shall not be accepted. Double-wall acoustically-lined ductwork shall be removed from the job site and shall not be used if liner is allowed to become wet to any degree.
17. Rectangular low velocity ductwork shall be constructed from galvanized steel sheets of lock form quality per ASTM A653 with a G60 zinc coating (0.60 oz/ft^2), unless otherwise shown on the contract documents. Sheets shall be free of pits, blisters, slivers, and un-galvanized spots.
18. Insulated-flexible acoustical air ducts shall be FLEXMASTER USA TYPE 1M, THERMAFLEX Type M-KE, or approved equal, suitable for up to 10" w.g. positive pressure and rated velocity of 5500 FPM. Flexible ductwork shall meet NFPA 90A standards, conform to UL standard 181, and be ETL listed Class 1 air duct. Flexible duct shall have a flame spread of less than 25 and smoke developed of less than 50. Flexible ductwork shall be fabricated with a polyethylene or chlorinated polyethylene inner film, wrapped in 2" thick with a thermal conductance of R-6 fiberglass insulation, with an outer reinforced metallized vapor barrier. The inner film shall be supported by a corrosion resistant galvanized steel helix formed and mechanically locked to the polyethylene fabric. The inside bend radius shall be ½ x inside diameter in all sizes. Flexible branch ductwork to diffusers shall be limited to maximum length of 5 feet long and maximum velocity of 600 feet per minute. Flexible duct connections at variable air volume terminals shall be a maximum of 3 feet long. Contractor to provide proper flex duct size to ensure velocity limit is not exceeded. Support flexible ducts a minimum of every 4 feet. Supports shall not compress or constrict the flexible duct. Refer to the diffuser installation details on the drawings.

19. Provide flexible connections of fiberglass between ducts and air-handling unit connections, fan powered VAV boxes, fan coil units, air-handling unit supply fans and discharge plenums, and exhaust fans. Connector shall be constructed using double lock gripping fingers at metal to fabric contact. Connector shall be rated airtight and watertight up to 10" w.g. positive to 10" w.g. negative pressure. Provide flexible connections, not less than 4 inches wide, constructed of approved fireproof, waterproof, non-asbestos, glass fabric, at the inlet and outlet connection of each fan unit, securely fastened to the unit and to the ductwork by a 24 gauge galvanized steel band provided with tightening screws. There shall be no metal-to-metal contact at flexible connections. There shall be no stretching of the flexible material at flexible connections. The connection shall be UL listed, to meet NFPA 90A and 90B requirements and the following applications:

    Indoor: Neoprene coated glass fabric, minimum 30 oz./sq.yd., DUCTMATE "PROflex™" or approved equal.

20. Fabricate ductwork with airtight joints, presenting smooth surface on inside, neatly finished on outside; construct with curves and bends to aid in easy flow of air. Unless otherwise indicated, make inside radius of curves and bends at least width of ducts. Where square elbows have to be used, provide double wall turning vanes in all elbows. Deflecting vanes shall be double wall blades, fit into side rails, and screw or rivet to duct elbow in field. Blades and side strips shall be small or large double vanes as detailed in SMACNA Duct Manual. DUCTMATE "PROrail™" or approved equal.

21. Construct, brace, and support ducts and air chambers in a manner that they will neither sag nor vibrate to any perceptible extent when fans are operating at maximum speed or capacity.
22. Provide sandwich type or square framed access doors for service temperature and pressure required, where indicated and where not indicated, in locations and of sizes which will afford easy access to multi-blade dampers, smoke detectors, fire dampers, and other equipment and devices requiring inspection and servicing. Access doors shall be installed to avoid lights, piping, conduit, ceiling grid, etc., to provide unobstructed access. Access doors shall be installed on the underside of the ductwork. Access doors shall be a minimum of 24" x 18" where possible. Access doors in all factory fabricated ductwork shall be factory installed and sizes and locations shall be identified on the ductwork shop drawing submittal. In non-accessible ceilings, provide access doors in ceiling. DUCTMATE or approved equal.
23. Connect ductwork to intake and discharge louvers, dampers, and other work installed in various trades requiring sheet-metal connections.
24. Make sheet-metal connections to masonry work airtight and watertight in approved manner.
25. Provide opposed-blade dampers for control of air volume and for balancing system, where indicated or required. Dampers shall be of sheet metal at least one gauge heavier than duct and reinforced; shall be installed in an accessible location. Provide indicating quadrant and locking device for adjusting and locking dampers in position. Provide extended shafts on all volume dampers greater than the thickness of the insulation to provide free movement of damper positioner. Stiffen duct at damper location, install damper in manner to prevent rattling.
26. Provide square to round transition fittings with balancing damper at all round-duct take-offs to supply diffusers and registers.
27. Provide access doors in building walls and ceilings where damper quadrants are concealed in shafts or above non-accessible ceilings.
28. Duct sizes are inside free area. Increase duct sizes as required.
29. Ductwork and accessories shall not be delivered to the job site until just prior to erection and must be stored in an approved manner.
30. All ductwork shall be internally cleaned by vacuuming prior to installation.
31. All ductwork open ends shall be sealed with polyethylene and duct tape during construction after hanging.

B. Exhaust Hood:

1. Provide size indicated, Model WRH as manufactured by GREENHECK, or approved equal.
2. Roof exhaust hoods shall be constructed of heavy gauge aluminum. Hoods shall be constructed of precision formed, arched panels with interlocking seams. Bases shall be constructed so that the curb cap is 6 in. larger that the throat size. Base height shall be 12 inches. Hood support members shall be constructed of galvanized steel and fastened so that the hood can be either removed completely from the base or hinged open.
3. Birdscreens constructed of 0.5 in. galvanized steel mesh shall be mounted horizontally across the discharge area of the hood.

C. Grilles, Registers, and Diffusers:

1. Refer to drawings for types, material, models, finishes as manufactured by PRICE, TITUS, METALAIRE, or approved equal. Air devices shall have performance characteristics (throw, noise, and pressure drop) equal to air devices scheduled on the drawings. This information shall be provided with the submittal.
2. Grille and register frames and louvers shall be one-piece construction.
3. Paint interior surfaces of ducts behind grilles and registers with flat black enamel.

D. Series Hot Water Heat Variable Air Volume Terminal Boxes:

1. General: Provide fan powered variable air volume series terminals complete with casing, fan section, primary air valve, hot water heating coil, and discharge plenum, where indicated. Units shall be manufactured by GREENHECK, TRANE CO., PRICE, or approved equal. Acoustical data shall be certified in accordance with ARI 880. Acoustical data shall consider effect of discharge plenum and outlet combination.
2. Casing: Provide 22-gauge, acoustically lined, galvanized-steel casing. The interior surface of the unit casing is acoustically and thermally lined with 1-inch, 1.5 lb/ft3 density glass fiber with foil facing. The insulation R-Value is 4.1. The insulation is UL listed and meets NFPA-90A and UL 181 standards as well as bacteriological standard ASTM C 665. There shall be no exposed edges of insulation (complete metal encapsulation).
3. Primary Air Valve: Maximum leakage rate shall be 1% at 4" w.c. pressure differential. Provide with multiple point averaging flow sensor to provide primary airflow measurement within ±5% of rated unit airflow with 1-1/2 diameters of straight duct upstream of unit. Provide integral flow taps and calibration chart on each unit.
4. Fan wheel shall be forward curved.
5. Motor shall be permanently lubricated, direct drive, permanent split capacitor type. Provide thermal overload protection. Maximum motor temperature rise on all speeds of 55°C. Motor voltage shall be as scheduled on the drawings. Motor and fan assembly shall be isolated from terminal casing using rubber isolators.
6. Factory mount variable speed (SCR) controller to adjust fan motor speed. Controller shall have minimum stop to avoid overheating of motor. The controller adjustment knob shall be located on the exterior of the control panel. Provide a factory mounted and wired fan disconnect switch.
7. Hot Water Heating Coil: Provide factory-mounted hot water heating coils constructed of seamless copper tubes and plate aluminum fins mechanically bonded to tubes. Coils shall be rated for a minimum working pressure of 150 psi. Coil performance shall be certified in accordance with ARI 410.
8. Factory mount controller and damper operator provided by BAS manufacturer. Furnish and install a 40-VA transformer.

2.8 VIBRATION ISOLATION

A. Spring Isolators:

1. Mechanical equipment indicated below shall be isolated from the structure by resilient vibration and noise isolators. Equipment to be isolated includes fan powered variable air volume terminal units and inline exhaust fans. Minimum deflection shall be 1".

    a. Hangers shall be type PC30N as manufactured by Mason Industries, Inc. or equal.
    b. Hangers shall be pre-compressed and locked at the rated deflection by means of a resilient upstop to keep the equipment at a fixed elevation during installation.
    c. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load.
    d. Deflection shall be clearly indicated by means of a scale.
    e. Submittals shall include a drawing of the hanger showing the 30° capability.
    f. Springs shall be seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod to hanger contact.
    g. Spring diameters and the lower hole sizes, shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing.

2.9 MEASUREMENT AND CONTROL

A. Variable Frequency Drives:

1. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.

2. Provide variable speed frequency drive (VFD) units for the following equipment:

    a. RTU-1, 3, 4, 5, 7, and 9 Supply Fans (one VFD per fan section)
    b. RTU-1A and 2A Exhaust Fans (one VFD per fan section)
    c. RTU-5, 7, 8, 10 Exhaust Fans (one VFD per fan section)
    d. Condenser Water Pumps, P-5 and P-6

3. Manufacturers:

    a. ASEA BROWN BOVERI
    b. DANFOSS GRAHAM
    c. TOSHIBA

4. The VFD package as specified herein shall be enclosed in a UL Listed Type 1 enclosure for indoor applications, completely assembled and tested by the manufacturer in an ISO9001 facility.

a. Environmental operating conditions: VFDs shall be capable of continuous operation at 32 to 120 °F ambient temperature or VFD must be oversized to meet these temperature requirements.
b. Enclosure for indoor applications shall be rated UL Type 1, Enclosures for outdoor applications shall be UL Type 3R. All enclosures shall be UL listed as a plenum rated VFD.

5. All VFDs shall have a Short Circuit Withstand Rating of not less than the rating of the connected equipment in accordance with UL508.

6. All VFDs shall have the following standard features:

a. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference.
b. There shall be a built-in time clock in the VFD keypad.
c. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up.
d. The VFD shall have cooling fans that are designed for easy replacement.
e. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip.
f. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
g. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients.
h. The input current rating of the VFD shall be no more than 3% greater than the output current rating.
i. The VFD shall include a coordinated AC transient surge protection system.
j. The VFD shall provide a programmable loss-of-load Form-C relay output.
k. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of mechanical failure / jam condition causing motor overload
l. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control.
m. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user.
n. Door interlocked, pad lockable molded case switch that will disconnect all input power from the drive and all internally mounted options.

7. All VFDs to have the following adjustments:

    a. Three (3) programmable critical frequency lockout ranges.
    b. Two (2) PID Set point controllers allowing pressure or flow signals to be connected to the VFD.
    c. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (i.e., valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
    d. Two (2) programmable analog inputs shall accept current or voltage signals.
    e. Two (2) programmable analog outputs (0-20ma or 4-20 ma).
    f. Six (6) programmable digital inputs for flexibility in interfacing with external devices.
    g. Three (3) programmable, digital Form-C relay outputs.
    h. Run permissive circuit - There shall be a run permissive circuit for damper or valve control.
    i. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active.
    j. Seven (7) programmable preset speeds.
    k. Two independently adjustable accel and decel ramps with 1 - 1800 seconds adjustable time ramps.
    l. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise.
    m. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
    n. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD.
    o. The VFD shall include password protection against parameter changes.

8. The Keypad shall include a backlit LCD display. All VFD faults shall be displayed in English words. The keypad shall include the following assistants:

    a. Start-up assistant
    b. Parameter assistants
    c. Maintenance assistant
    d. Troubleshooting assistant
    e. Drive optimizer assistants

9. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times:

    a. Output Frequency
    b. Motor Speed (RPM, %, or Engineering units)
    c. Motor Current
    d. Motor Torque
    e. Motor Power (kW)

f. DC Bus Voltage
g. Output Voltage

10. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed. 2) Operate in a specific fireman's override PID algorithm. The mode shall override all other inputs except customer defined safety run interlocks, and force the motor to run in one of the two modes above.

11. Serial Communications:

a. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. Optional protocols for LonWorks, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.

b. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

1) Data Sharing – Read Property – B.
2) Data Sharing – Write Property – B.
3) Device Management – Dynamic Device Binding (Who-Is; I-Am).
4) Device Management – Dynamic Object Binding (Who-Has; I-Have).
5) Device Management – Communication Control – B.

c. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

d. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.

e. The VFD / bypass shall allow the DDC to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function.
f. The VFD shall include an independent PID loop for customer use.

12. All VFDs shall include EMI/RFI filters.
13. All VFDs through 75HP at 480V shall be protected from input and output power mis-wiring.

14. Bypass Controller:

a. A complete factory wired and tested bypass system shall be provided with the following operators:

1) Bypass Hand-Off-Auto
2) Drive mode selector
3) Bypass mode selector
4) Bypass fault reset

b. The bypass shall include an LCD display that allows the user to access owner requested data including but not limited to fails, bypass power (KW), and energy savings.
c. The following indicating lights (LED type) or keypad display indications shall be provided.

15. Emergency Stop Function:

a. An emergency stop function shall meet all of the following requirements:

1) The function shall override all other functions and operations under all conditions.
2) Reset must not initiate a restart.
3) An emergency stop shall operate in such a way that, when it is activated, the hazardous movement of the machinery is stopped and the machine is unable to start under any circumstances, even after the emergency stop is released. Releasing the emergency stop only allows the machine to be restarted.

4) The emergency stop shall stop hazardous movement by applying a stop category 0.

(a) Emergency stop category 0 (according to EN 60204-1) means that the power to the motor shall cut off immediately. Stop category 0 is equivalent to the safe torque off (STO)function, as defined by standard EN/IEC 61800-5-2.

16. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.
17. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current.
18. 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.
19. The VFD Product Warranty shall be 24 months from the date of certified start-up. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

B. Air Purification System:

1. This section describes the design, performance and installation of an air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details and equipment schedules.
2. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit furnished and manufactured by GLOBAL PLASMA SOLUTIONS model GPS-Ibar, AMERICAN ION, ACTIVE AIR SOLUTIONS, PHENOMENAL AIRE, or approved equal.
3. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within.

4. The Bi-polar Ionization system shall be capable of:

    a. Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).
    b. Controlling gas phase contaminants generated from human occupants, building structure and furnishings.
    c. Capable of reducing static space charges.

    d. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:

        1) MRSA - >96% in 30 minutes or less
        2) E.coli - > 99% in 15 minutes or less
        3) TB - > 69% in 60 minutes or less
        4) C. diff - >86% in 30 minutes or less

    e. The ionization device shall be designed such that it may fit into any scheduled mounting configuration. The ionization device shall be powered from the control board without having to require revised fusing.
    f. The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable.

g. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system. Air purification system shall be capable of wash down duty.

5. Ionization Requirements:

   a. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and integral power supply. The Bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be capable of being powered by 18VAC, 24VAC, 110VAC or 200VAC to 240VAC without the use of an external transformer. Ionization systems requiring isolation transformers shall not be acceptable.
   b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced. Imbalanced levels shall not be acceptable. An LED indicator shall be provided to prove ion output is activated.
   c. Ionization output from each electrode shall be a minimum of 200 million ions/cc when tested at 2" from the ionization generator.

6. Ozone Generation:

   a. The operation of the electrodes or Bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation. There shall be no detectable ozone generation during any operating condition, with or without airflow.

7. Electrical Requirements:

   a. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept an electrical service of 24VAC, 115 VAC or 200-240VAC, 1 phase, 50/60 Hz. The contractor shall coordinate electrical requirements with air purification manufacturer during submittals.

8. Control Requirements:

   a. All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset.
   b. The installing contractor shall mount and wire the Plasma device within the air handling unit specified or as shown or the plans. The contractor shall follow all manufacturer IOM instructions during installation.

   c. A control relay shall be provided to sense the ion output and indicate to the BAS via dry-contacts that the ion output is functioning normally. NO and NC contacts shall be available to the BAS system for ease of integration.

1) Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Detector with integral BAS contacts.

2) The Plasma Detector sensor shall be designed to these minimum standards:

(a) Ability to detect both positive and negative ion levels from 1,000 ions/cc to 20 million ions/cc minimum. Detection limit shall be field adjustable based on sensor mounting location and manufacturer being sensed.
(b) Plasma detector shall have integral dry alarm contacts for connection to the BAS to prove the ion system is operating properly and the ion system output is above the minimum preset threshold from the sensor manufacturer. The alarm shall activate when either positive or negative ion output drops below the preset setpoint. Cold plasma systems only providing indication the input power is applied or output power is present shall not be acceptable. The independent cold plasma detector shall be capable of working with any air purification manufacturer's system.
(c) Cold plasma detector shall have an input voltage of 12VDC, 24VDC or 24VAC user selectable.
(d) Cold plasma detector shall be capable of duct mounting or integral air stream mounting.
(e) Housing shall be constructed of fire retardant ABS plastic.
(f) Temperature and humidity shall have no effect on the cold plasma detector output accuracy.
(g) The alarm output shall be provided with NO, NC and C terminals for ease of integration to the BAS. The contacts shall be rated for up to 5 amps at 230VAC or up to 24VDC at 2 amps.
(h) A BACnet or LonWorks control interface shall be provided by the cold plasma detector manufacturer.

9. GPS-IMOD Equipment Requirements:

a. Electrode Specifications (Bi-polar Ionization):

1) Each Plasma Generator with Bi-polar Ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. A minimum of sixteen 316 medical grade stainless steel ion needles per foot of coil face width shall be provided. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, and performance output reduction over time, ozone production and corrosion.
2) Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.

b. Air Handler Mounted Units:

1) Where so indicated on the plans and/or schedules Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and wire it to the remote mount power supply using the high voltage cables provided by the air purification manufacturer. A 115VAC or 230VAC circuit shall be provided to the ion generator power supply panel. Each ion generator shall be designed with an aluminum casing, integral grounding connection and high voltage quick connector.

C. Low Voltage Condensate Overflow Shut-off Switch:

1. Low voltage condensate overflow shut-off switches shall be installed on all condensate drain pans as manufactured by RECTORSEAL approved equal.
2. The condensate shut-off switch shall detect rising water in condensate drain pans and interrupts the thermostat circuit to shut off the unit before flooding occurs. The device shall be installed on the primary drain pan rim with a two-piece clamp system that not require drilling.
3. Mechanical equipment without adequate pan clearance to install a primary drain pan switch shall provide a switch installed on the primary drain pan outlet. The condensate shut-off switch shall detect downstream clogs in condensate drains and interrupts the thermostat circuit to shut off the unit before flooding occurs.
4. The switch shall incorporate a high capacity 5-amp, 24 volt AC magnetic float switch in a fully housed protective cover. The housing shall include a pull up test knob for functional testing of system.
5. The switch shall include an alarm wire to connect to the BAS. The switch shall send an alarm signal to the BAS frontend workstation. The mechanical contractor shall be responsible for coordinating the switch connections with the controls contractor.
6. The switch shall be UL Listed to comply with UL 508.

PART 3 - EXECUTION

3.1 TESTS

A. Refer to Section 230593 “Testing, Adjusting and Balancing” for related requirements.

B. At their discretion the Owner shall be represented at all tests. Contractor shall provide 48 hours’ notice to the Owner prior to the tests unless otherwise specified.

C. Before insulation is installed and before piping is concealed, test water piping hydrostatically and prove tight under 100 psig pressure. Test pressure shall be held for minimum of 8 hours. An air test in lieu of water may be used when danger of freezing is possible and when approved.

D. Coupled pumps shall be field aligned in accordance to the manufacturer’s recommended procedures, alignment completed prior to shipment is not acceptable. After the equipment has

been aligned, the contractor shall provide a written report verifying that the pumps vertical and horizontal angularity and parallel offset gap are within one of the following tolerances:

1. Pump parallel offset gap shall be within 1/64" at operating speed and pump angularity shall be within 1/64" per inch of coupler radius.
2. The manufacturer's recommended tolerance for the application and with the Engineer's approval.

E. Test all gas piping at 50 psig with oil-free compressed air for 2 hours with no loss in pressure.

3.2 WATER TREATMENT

A. Prior to commencement of water treatment, including initial flushing of hydronic loop piping, contractor shall submit qualifications of the water treatment specialist engaged by the contractor to the Engineer for review and approval. Include in the submittal a detailed schedule of the flushing and final water treatment procedure. This schedule shall correlate with the contractor's schedule of construction and shall include the phased installation and operation of the hydronic system during construction (where applicable). Include all chemicals to be used for cleaning the hydronic systems during the flushing and cleaning process and the chemicals required to treat the water once the system is refilled and prior to system start up. The water treatment specialist shall calculate the volume of water required in each hydronic system, including the phased processes, and determine the required chemical treatment mixtures and how they will be applied. Submit calculations to the Engineer for review and approval. Contractor shall provide a minimum of 2 weeks' notice to the Architect, Engineer, and Owner's representative of scheduled cleaning, flushing and water treatment events.

B. Prior to filling the condenser water piping systems with hydronic fluids, the contractor shall ensure that all equipment bypass flushing valves are open, and all equipment isolation valves are closed. Immediately upon introduction of hydronic fluids to the system, the contractor shall thoroughly flush and clean system with a detergent mixture to remove previously accumulated dirt and other organic residue, sediment and debris from system. The contractor shall remove and clean all system strainers free of debris, blow down all devices, clear pump suction diffuser strainers and disassemble, clean and reassemble air dirt separators. The contractor shall repeat this process until all strainers run clean. As additional phases of the piping system are installed, and brought online, the contractor shall repeat the flushing process as necessary until all strainers run clean. All cleaning and flushing and final chemical treatment of hydronic systems shall be observed and directed by the contractor's water treatment specialist.

C. Refer to specification section 232533, "Water Treatment and Temporary Sub-Micron Filtration Hydronic Systems" for water treatment and sub-micron filtration requirements.

D. The flushing and cleaning process shall take as long as necessary to ensure strainers, when examined after each flushing, are clean and shall remain clean during the construction processes. Bi-weekly examination will take place during the construction process once the hydronic systems are started. Should it be determined that the quality of the water does not meet the requirements prescribed by these documents, the contractor shall conduct regular

flushing of the building hydronic systems until the water quality is restored to an acceptable state. The processes will be provided at no additional cost to the owner.

E. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturer's instructions and as recommended by the water treatment specialist. After flushing with the detergent and/or dilute acid concentrations, the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out. Flush water shall be disposed in accordance with all local, state, and federal regulations.

F. If required due to project phasing, provide all necessary isolation valves, pumping systems and piping required to facilitate a phased or partial system flush. Do not allow water from hydronic systems that have not been cleaned, flushed and treated to enter or circulate through systems that have been cleaned, flushed and treated. In such instances where water from hydronic systems that have not been cleaned, flushed and treated is allowed to mix with water in hydronic systems that have been cleaned, flushed, and treated, an entire system cleaning, flushing and chemical treatment shall be required. If portable pumping systems are provided, pumps must be capable of delivering design water flow and pressure.

G. At the completion of the cleaning and flushing, a water test shall be performed by the water treatment specialist to establish that the pH of the refilled circulating water is below 9.0 pH or within 0.5 pH of the makeup water. In addition, the conductivity of the system should be within 10% of the makeup water.

H. Water Treatment Requirements: Water for the hydronic water loops shall be analyzed and treated by a professional water treatment specialist who is familiar with the operating conditions and materials of construction specified, headers and associated piping. Cycles of concentration shall be controlled such that recirculated water quality is maintained within the following parameters. Continue to flush and clean the pipe as required and to add chemicals as recommended by the water treatment specialist to achieve the following results:

Chilled Water Systems:

1.	pH	8.0 – 10.5
2.	Chlorides/Sulphates	<200 ppm
3.	Turbidity	<20 NTUs
4.	Conductivity	<3500 micromhos
5.	Nitrite (inhibitor)	400 – 800 ppm
6.	Molybdenum (inhibitor)	50 – 250 ppm (if nitrite is not used)
7.	Azole (inhibitor)	>5 ppm
8.	Total Iron	<3.0 ppm (some folks will have this at <1.0 ppm)
9.	Total Copper	<.25 ppm (some folks will have this at <1.0 ppm)
10.	Total Bacteria Counts	<1,000 CFU/ml

Hot Water Systems:

1.	pH	8.0 – 10.5
2.	Chlorides/Sulphates	<200 ppm

3.	Turbidity	<20 NTUs
4.	Conductivity	<3500 micromhos
5.	Nitrite (inhibitor)	800 – 1200 ppm
6.	Molybdenum (inhibitor)	100 – 250 ppm (if nitrite is not used)
7.	Azole (inhibitor)	>5 ppm
8.	Total Iron	<3.0 ppm (some folks will have this at <1.0 ppm)
9.	Total Copper	<.25 ppm (some folks will have this at <1.0 ppm)

Condenser Water Systems:

1.	pH	7.0 – 9.0
2.	Chlorides/Sulphates	<200 ppm
3.	Turbidity	<20 NTUs
4.	Conductivity	1,000– 1,350 micromhos (depending on cycles of concentration)
5.	Cycles of Concentration	5 - 7
6.	Total Hardness	<600 ppm
7.	Total Alkalinity	<400 ppm
8.	LSI	<2.5
9.	Azole (inhibitor)	>2 ppm
10.	Phosphonate	3 – 10 ppm
11.	Total Iron	< 3.0 ppm (some folks will have this at <1.0 ppm)
12.	Total Copper	<.25 ppm (some folks will have this at <1.0 ppm)
13.	Total Bacteria Counts	<10,000 CFU/ml
14.	Free Halogen minimum 3 times per week	.25 - .75 ppm continuous or .5 – 1.5 ppm slug feed @

a. Submit documentation of this analysis and treatment to the Engineer for review and approval. Water tests shall be conducted monthly for all hydronic systems operating during construction and again prior to substantial completion.

I. As a requirement of substantial completion, the contractor shall demonstrate the successful filtration and treatment of the hydronic systems and provide a maintenance record of the water conditions during the construction process. The water treatment specialist shall provide a written report of conditions found for review and verification by Owner.

END OF SECTION 230500

SECTION 230593 - TESTING, ADJUSTING AND BALANCING (TAB)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 “Mechanical General Provisions” apply to this Section.

1.2 SCOPE OF WORK

A. The General Contractor shall obtain the services of an independent testing and balancing agency whose business is limited to testing, adjusting and balancing and shall be certified by AABC (or NEBB). Agency shall have been in the TAB business for a minimum of 5 years. The TAB (Testing, Adjusting and Balancing) Agency shall be a direct subcontractor of the General Contractor and not affiliated in any way with the Mechanical Contractor.

B. Testing and balancing shall be performed in accordance with National Standards for Testing and Balancing Heating, Ventilating and Air-conditioning Systems, 2002, as published by Associated Air Balance Council (AABC).

C. All work shall be performed under the direct supervision of a certified TAB Engineer. All other personnel shall be regular full-time employees of the TAB Agency.

D. Test and Balance Agency shall submit within 30 days after receipt of construction contract two copies of qualifications, including current TAB Engineer’s certificate and National Project Certification Performance Guaranty.

E. TAB work shall not commence until all components of the HVAC system have been installed completely, including all power wiring and controls and all equipment has been started and run tested in each mode of operation. Should any items be found incomplete at the time that TAB work is performed, the TAB Agency shall immediately notify the General Contractor and Owner’s Representative of any deficiencies found. The General Contractor shall be responsible for correcting reported deficiencies and verifying that the system is 100% complete, operable and ready for TAB work to proceed.

PART 2 - PRODUCTS

2.1 MATERIAL AND EQUIPMENT

A. Provide all necessary instrumentation required to measure and adjust the HVAC air and water systems.

B. Equipment and instruments shall be of types approved by the Owner's Representative and/or manufacturers of devices installed.

C. Instruments used for testing and balancing of air and hydronic systems shall have calibration verified within a period of 12 months prior to balancing.

PART 3 - EXECUTION

3.1 GENERAL, MECHANICAL AND ELECTRICAL CONTRACTOR'S RESPONSIBILITY

A. The General Contractor shall be responsible for directing the Mechanical and Electrical Contractors to fulfill the Contractors' Responsibility for Testing, Adjusting and Balancing as required in Section 230100. TAB work shall not commence until the conditions of paragraph 1.2.E of this Section and all requirements of Section 230100 for TAB have been completed.

3.2 TAB AGENCY'S RESPONSIBILITY

A. Carefully review the drawings and Specifications for the various systems noting all facilities incorporated in the design for purposes of adjusting and balancing. Should it be deemed necessary to provide additional dampers, baffles, valves, or other devices which would aid in the required adjusting and balancing, same shall be provided by the installing contractor.

B. The TAB Agency shall report any and all deficiencies that prohibit adjusting and balancing in accordance with the Contract Documents to the Contractor and the Owner's Representative.

C. Adjust all water piping, duct and equipment, including valves, controls, dampers, cocks, etc., to properly perform to ±10% of their respective design quantities of flow.

D. Determination of the air volumes shall be made by pitot tube and differential draft gauge for all supply, return, outdoor air and exhaust air ducts. Openings for pitot traverses shall be provided as required and shall be fitted with neat removable plugs or covers. Air quantities at grilles, registers, diffusers, etc., shall be measured as recommended by the various manufacturers of the outlets.

1. Fan powered VAV boxes shall be balanced in a manner that assures the design primary airflow is delivered to the VAV box at maximum and minimum air flow. The manufacturer provided flow measurement device may or may not be accurate due to upstream duct conditions. (see 3.2.H.7 for reporting requirements)

E. The Test and Balance Agency shall perform the following:

1. Adjust fan RPM, tighten and align fan belts, measure operating amps.
2. Adjust volume dampers to obtain designed air volume.
3. Adjust grilles, diffusers and registers to obtain designed airflow and air pattern.

4. Set balancing valves to obtain designed water flow at units, coils and branches.
5. Adjust each air handler to obtain designed airflow.
6. Adjust dampers to provide design outside air quantities.
7. Adjust airflow exhausted from and supplied to hoods.
8. In cooperation with the ATC Contractor's representative, setting adjustments of automatically controlled dampers to operate as specified. The TAB Agency shall inform ATC Contractor of all abnormalities in sequencing and/or calibration of components discovered during balancing.
9. Final settings of dampers and valves shall be permanently marked. Where provided, memory stops and locking devices shall be adjusted and locked to the final setting.
10. Assist Fire Alarm Contractor in the testing of all duct smoke detectors. Measure the air velocity across each duct smoke detector with air handling unit at full airflow.

F. Before the work is offered for Final Acceptance, all equipment shall be run through a test to demonstrate that it has been adjusted to meet the requirements of the drawings and Specifications. Copies of the test and adjustment data shall be submitted in a report to the Owner's Representative prior to final inspection.

G. The TAB Report shall include a General Comments section providing an overview of systems operation, observations of system installation abnormalities and deficiencies, problems encountered, etc. If required, provide explanation of methods of measurement and disparity between measured and design quantities.

H. Test and Balance Agency Report shall include the following data for each system. All sheets shall be neatly typed. Balancing Agency shall submit with his report a set of neatly marked plans identifying location of each piece of equipment, air terminal, flow measuring device and points of traverse. Report all measured quantities and design quantities where applicable.

1. CFM of each supply, return, exhaust grille and diffuser.
2. RPM and CFM of each fan.
3. Supply, return and outdoor air CFM of each AHU and fan terminal unit where required.
4. Air pressure drop across A/C unit cooling coils.
5. Air pressure drop across each filter bank.
6. Discharge and suction static pressure of each fan.
7. Maximum and minimum differential pressure and corresponding CFM of each terminal box.
8. Voltage rating and operating volts of each fan motor. For fan motors requiring three-phase power, record voltage of each individual phased leg and check for voltage imbalance.
9. Temperatures and pressures for each chiller at maximum capacity, including the following:

    a. Entering and Leaving water temperature.
    b. Water pressure drop.

10. CFM of each exhaust hood.

11. Temperatures for each air handling unit at maximum capacity including the following measurements:

    a. Entering and Leaving air temperature at each coil.
    b. Entering and Leaving water temperature at each coil.
    c. Entering and Leaving air temperatures at each energy recovery wheel on supply and exhaust side of wheel.

12. Air Handling unit is defined as any equipment that consists of a fan and coil, including existing AHUs to be refurbished, VAV box terminal units, cabinet unit heaters, etc.

13. Temperatures for each heat exchanger device at maximum capacity, including the following:

    a. Entering and Leaving water temperature.
    b. Entering and Leaving air temperature.

14. Nameplate data of each piece of HVAC equipment installed.
15. GPM of each pump and corresponding suction and discharge pressure.
16. Voltage rating and operating volts of each pump motor. For pump motors requiring three-phase power, record voltage of each individual phased leg and check for voltage imbalance.
17. Amp rating and operating amps of each pump. For pump motors requiring three-phase power, record amps of each individual phase.
18. Differential pressure and corresponding GPM across each flow measuring device, including automatic flow control devices.
19. Final percent setting after adjustment of each balancing valve where applicable.
20. Velocity across each duct smoke detector at full airflow.

I. During the Final Inspection, the Agency shall have present all necessary instrumentation and an individual to make readings of select information which was submitted in the balance report. The select readings shall be made where directed by and in the presence of the Owner's Representative and shall not deviate more than 5% from the values submitted in the report.

J. The Owner's Representative may select no more than 20% of all reported data for rechecking. If more than 20% of data verified is not within ±5% of submitted data, the Owner's Representative may void entire report and ask for complete rebalancing. The field check shall be made within 45 days of approved TAB submittal.

END OF SECTION 230593

SECTION 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 “Mechanical General Provisions” apply to this Section.

1.2 SUBMITTALS

A. Submit manufacturers’ data on all insulation products, schedule which indicates where each product is to be used and thickness of each product.

1.3 WARRANTY-GUARANTEE

A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of materials and workmanship for a period of 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INSULATION – GENERAL

A. All insulation shall have a composite (insulation, jacket or facing and adhesive used to adhere the facing or jacket to the insulation) fire and smoke rating as requested by ASTM E84, NFPA 255 and UL 723, not exceeding:

Flame spread	25
Smoke developed	50

B. Accessories, such as adhesive, mastics, cements, tapes and fire-resistant cloth for fittings, shall have same fire and smoke ratings as components listed above.

C. Installation of insulation shall be accomplished in strict accordance with manufacturer’s recommendations and shall be CERTAINTEED, OWENS-CORNING, JOHNS MANVILLE or KNAUF INSULATION for glass fiber insulation; ARMACELL for flexible unicellular insulation.

2.2 PIPE INSULATION

A. Glass fiber insulation having a thermal conductivity not greater than 0.24 Btu x in./hr. x sq. ft. x °F in a mean temperature of 75°F. Insulation shall have factory-applied all-purpose jacket.

B. Flexible unicellular insulation having a thermal conductivity not greater than 0.27 Btu x in./hr. x sq. ft. x °F in a mean temperature of 75°F.

2.3 DUCT INSULATION

A. Blanket Type within the conditioned space: Glass fiber, ¾-lbs/cu. ft., foil faced, vapor-sealed flexible duct insulation. Thermal conductivity shall not exceed 0.29 Btu x in./hr. x sq. ft. x ºF.

B. Board Type within the conditioned space: Glass fiber, 3.0-lbs./cu. ft., foil faced, vapor-sealed board insulation. Thermal conductivity shall not exceed 0.23 Btu x in./hr. x sq. ft. x ºF.

C. Blanket Type in unconditioned space or outside building: Glass fiber, 1-1/2-lbs/cu. ft., foil faced, vapor-sealed flexible duct insulation. Thermal conductivity shall not exceed 0.25 Btu x in./hr. x sq. ft. x ºF.

D. Board Type in unconditioned space or outside building: Glass fiber, 3.0-lbs./cu. ft., foil faced, vapor-sealed board insulation. Thermal conductivity shall not exceed 0.23 Btu x in./hr x sq. ft. x ºF.

2.4 DUCT LINER

A. 2" thickness glass fiber insulation as manufactured by JOHNS MANVILLE, LINACOUSTIC RC™. Insulation shall conform to the physical properties and requirements of ASTM C1071. Insulation shall be installed in strict accordance with the manufacturer's instructions.

1. Glass fiber, 3.0-lbs./cu.ft., insulation having a thermal conductivity not greater than 0.24 Btu x in./hr. x sq. ft. x ºF at a mean temperature of 75ºF. Insulation shall be factory applied. Insulation shall have a composite fire and smoke rating as required by ASTM E84, UL 723 and NFPA 255, not exceeding 25 flame-spread and 50 smoke developed.
2. Insulation shall be coated with an EPA-registered immobilized anti-microbial agent which shall effectively resist the growth of bacteria and fungi as proven by tests in accordance with ASTM G21 and G22. Insulation shall be rated for a maximum air velocity of 5,000 fpm when tested per UL 181, Section 17, with no fiber shedding. Edge coating shall be accomplished using Permacote SuperSeal and shall meet all the performance requirements of the insulation.

2.5 COLD EQUIPMENT

A. 6 lbs./cu. ft. density, flexible unicellular, sheet-type insulation.

2.6 HOT VESSELS

A. 3 lbs./cu. ft. density, glass fiber, semi-rigid board with all service jacket.

2.7 ALUMINUM PIPE JACKETS

A. Aluminum jacket shall be .016" thick (28 ga.) smooth aluminum sized to provide a minimum 2" self-gauging overlap longitudinal and circumferentially, minimum 3/4" by .015" thick (30 ga.) draw bands. Jacket shall be supplied with a factory-applied polykraft moisture barrier. CHILDERS PRODUCTS COMPANY, STRAP-ON JACKETING.

B. Provide fitting covers of same material as jacket and of same manufacturer.

2.8 CALCIUM SILICATE PIPE INSULATION INSERTS

A. Calcium silicate meeting ASTM C533, Type I, water resistant; rigid molded pipe; asbestos-free JOHNS MANVILLE Thermo-1200, or approved equal.

B. Thermal conductivity of 0.437 Btu at 300°F mean temperature as tested in accordance with ASTM C335.

C. Minimum compressive strength of 100 psi to produce 5% compression at 1-1/2" thickness.

D. Non-combustible as determined by test complying with ASTM E136.

E. Inserts shall have sufficient compressive strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation. Insulation inserts shall cover the bottom half of the pipe circumference 180 degrees and be not less in length than the protection shield. Vapor-barrier facing of the insert shall be of the same material as the facing on the adjacent insulation.

2.9 PVC PIPE JACKET FITTING COVERS

A. One-piece molded-type PVC plastic fitting covers and jacketing material, color matching JOHNS MANVILLE Zeston 2000, or approved equal.

B. Connections shall be made using pressure-sensitive color matching vinyl tape.

2.10 FIRE WRAP

A. Acceptable Manufacturer: THERMAL CERAMICS: 2102 Old Savannah Rd., Augusta, GA 30906; or approved equal.

B. Thermal Material: 2000°F rated core blanket, manufactured from patented bio-soluble Superwool chemistry (Calcium Magnesium Silicate).

1. Product: FireMaster FastWrap XL as manufactured by THERMAL CERAMICS.

    a. For commercial, kitchen hood exhaust ductwork: Insulation enclosure system tested and classified by UL (HNKT G18) to provide zero clearance to combustible construction and 2-hour fire rating per ASTM E 2336.

2. Fully encapsulated thermal material in fiberglass reinforced aluminum/polypropylene scrim.

    a. Encapsulation material marked with UL Classification Mark.
    b. Encapsulation material marked with ICC-ES report number ESR 2213.
    c. Collars supplied in 6-inch (150 mm) wide by 25 feet (7620 mm) long rolls.

3. Product Characteristics:

    a. Thickness: 1-1/2" ((38 mm).
    b. Nominal Density: of 6 pcf
    c. R-Value: 7.35 per layer of FireMaster Fast Wrap XL when tested in accordance with ASTM C518.
    d. Flame Spread: <25 when tested in accordance with ASTM E 84.
    e. Smoke Development: <50 when tested in accordance with ASTM E 84.

C. Accessory Materials:

1. Glass Filament Tape: Minimum 3/4 inch (19 mm) wide – used to temporarily secure blanket until permanent attachment using steel banding and/or steel insulation pins.
2. Aluminum foil Tape: Minimum 3 inches (76mm) used to seal cut edges.
3. Carbon Steel or Stainless Strapping Material Minimum: 1/2 inch (13 mm) wide and 0.015 inch (.38 mm) thick.
4. Steel Insulation Pins: Minimum 12-gauge, length sufficient to penetrate through duct wrap insulation.
5. Insulation Clips: Galvanized steel, minimum 1-1/2 inches (38 mm) round or square.
6. Through Penetration Firestop Sealants:

    a. Packing Material: Remove encapsulation material from FastWrap XL, use core blanket (white) as penetration packing material.
    b. Firestop sealants per applicable building code report and/or laboratory design listings.

7. Grease Duct Access Doors:

    a. Field fabricated access doors per Thermal Ceramics installation instructions.
    b. DuctMate F2-HT Doors (NFPA 96 Compliant, tested with FireMaster FastWrap XL per ASTM E 2336).

c. DuctMate Ultimate Door (NFPA 96 Compliant, UL Listed per UL 1978, tested with FireMaster FastWrap XL per ASTM E 2336).

d. FireMaster DuctMate F2-HT-XL3 Access doors are supplied as a complete installation with DuctMate F2-HT Door and 3 layers of FastWrap XL insulation installed as tested in accordance with ASTM E 2336. Supplied in standard door sizes of 6 by10 inches (152 mm by 254 mm), 8 by12 inches (203 mm by 305 mm), 12 by16 inches (305 mm by 406 mm) and 14 by18 inches (356 mm by 457 mm).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Insulation shall be installed by a licensed applicator and in strict accordance with the manufacturer's instructions. Deliver all materials to the job site and store in a safe, dry place. Use all means necessary at the job site to protect materials from dust, dirt, moisture and physical abuse before and during installation. Insulation that becomes damaged prior to installation shall not be installed and shall be removed from the job site. Insulation that becomes wet or damaged after installation shall be removed and disposed of and replaced with new insulation.

B. Surfaces to be insulated shall be cleaned free of dirt, scale, moisture, oil and grease prior to installation of the insulation.

C. Open ends of internally lined ducts shall be sealed using 6-mil plastic sheeting and attached using duct tape around the entire perimeter of the opening.

3.2 PIPING (GLASS FIBER INSULATION, UNLESS OTHERWISE NOTED)

A. Schedule:

Chilled Water:	1" thickness for pipe sizes up to 1-1/2" and 1-1/2" thickness for pipe sizes over 1-1/2".
Hot Water Heating:	1" thickness for pipe sizes up to 1-1/2" and 2" thickness for pipe sizes over 1-1/2".
Condenser Water: >80°F continuous	No insulation required on interior piping; 1-1/2" thickness on exterior piping

B. Fittings and valves on insulated piping smaller than 4" shall be insulated with fiberglass blanket to thickness equal to adjoining pipe insulation unless otherwise noted. Fittings and valves for insulated piping 4" and larger shall be insulated with segments of molded insulation, secured in place. On all fittings and valves, insulation shall be finished with a preformed PVC jacket.

C. For chilled water piping, fittings and valves located in main mechanical equipment room, flexible unicellular insulation shall be used. Provide with PVC jackets.

D. All valves and piping accessories above ceilings handling chilled water shall be completely insulated to prevent condensation.

E. All flexible unicellular and glass fiber piping insulation exposed to the weather shall be provided with PVC jacketing.

F. Glass fiber piping insulation, for pipe sizes 3" and larger, located in the Mechanical Equipment Room, shall be provided with aluminum jacketing up to a minimum height of 8'-0" above the floor.

G. No piping shall be insulated until it has been tested and thoroughly cleaned.

H. Provide pipe inserts between pipe hanger support shields and on piping 1-1/2" diameter or larger. Insulation inserts shall not be less in length than the following:

1-1/2" to 2-1/2" pipe size	10" long
3" to 6" pipe size	12" long

I. Hangers and supports for chilled water piping shall not injure or pierce insulation.

3.3 DUCTWORK

A. Definitions:

1. Concealed: Ductwork which shall be hidden from view by ceilings, walls, chases, or soffits, either by the work of this Contract, or by future tenant build-out work.
2. Exposed: Ductwork which is permanently in view, typically found in mechanical, storage, electrical, or other unfinished space.

B. Schedule:

Concealed Supply, Return, Relief and Outside Air Ductwork Externally Insulated: (inside the conditioned space)	2" thickness blanket
Exposed Supply, Return, Relief and Outside Air Ductwork Externally Insulated: (in all mechanical rooms and mechanical mezzanines)	2"thickness rigid board
Supply, Return, Outside and Relief Air Ductwork Internally Lined: (inside the conditioned space)	2" thickness liner

Supply Ductwork Downstream of VAV Terminals (including heating coils):	2" thickness liner
Plenums:	2" thickness
Transfer Ducts:	Not Required
Exhaust Ducts:	Not Required

C. Where indicated, internally line ductwork with 1" thickness acoustic duct liner.

D. Insulate necks and tops of all supply air diffusers, registers and grilles.

E. Provide duct liner in the supply, return and exhaust ducts between unit connections and the first elbow, not to exceed 15 linear feet. This requirement applies to all Variable Air Volume Terminal Boxes.

F. Blanket-type insulation shall be stapled and taped in accordance with manufacturer's instructions.

G. Insulation on ductwork over 16" in height or width must be attached with stick pins. When using self-adhesive pins, prepare surface to be applied to ensure adhesion.

H. Tape all edges of insulation to ensure that no insulation is exposed.

3.4 INSULATED DUCT COATING

A. Clean galvanized outer surface of sheet metal ductwork as recommended by the manufacturer of the duct coating.

B. Apply POLAR SEAL "prime security" over all exposed ductwork at a rate of 100 square feet per gallon. Use polyester scrim over any joints or open areas. Completely saturate scrim in the first coat of "prime security".

C. After first coat is dry (dries from milky white when wet to clear opaque when dry), apply second coat of "prime security" at a rate of 100 square feet per gallon and let dry.

D. Apply POLAR SEAL "top security" at a rate of 100 square feet per gallon and allow to dry.

E. After first coat is dry, apply a second coat of POLAR SEAL "top security" at a rate of 100 square feet per gallon.

3.5 COLD EQUIPMENT

A. Schedule:

Chilled Water and Dual-temperature Pumps:	2" thickness, flexible unicellular
Chilled Water System Chemical Feeder:	1/2" thickness, flexible unicellular
Chilled Water System Expansion Tanks, Basket Strainer and Air Separator:	2" thickness, flexible unicellular
Heat Exchangers:	Manufacturer’s Insulated Jacket

B. Install equipment thermal insulation products in accordance with manufacturer’s written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

C. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

D. Maintain integrity of vapor barrier on equipment insulation and protect it to prevent puncture and other damage.

E. Provide removable, insulated, galvanized steel box to cover parts of pumps and basket strainer which must be opened periodically for maintenance.

3.6 HOT VESSELS

A. Schedule:

Heat Exchangers:	1-1/2" thickness, rigid fiberglass
Blowdown Separator:	1" thickness, rigid fiberglass
Boiler Feed Unit:	1" thickness, rigid fiberglass

B. Install equipment thermal insulation products in accordance with manufacturer’s written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

C. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

D. Maintain integrity of jacket on equipment insulation and protect it to prevent puncture and other damage.

E. Apply insulation using the staggered joint method for both single- and double-layer construction, where feasible. Apply each layer of insulation separately.

F. Coat insulated surfaces with layer of insulated cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

G. Cover insulated surfaces with glass-cloth jacketing neatly fitted and firmly secured. Lap seams at least 2".

3.7 FIREWRAP

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Preparation:

1. Remove dirt and dust from surfaces of openings and items penetrating rated floors and rated walls.

D. Installation:

1. Install Firewrap in direct contact with the ductwork in accordance with manufacturer's instructions, applicable laboratory listings and building code reports and referenced standards. For additional complex duct design installation recommendations, see the Thermal Ceramics' complete installation guide.

    a. For commercial, kitchen hood exhaust ductwork: Installation shall be performed by an experienced contractor per manufacturer instructions, applicable UL Listings and ICC-ES building code report (ESR 2213 or ESR 2832). Provide UL Listed liquid tight Thermal Ceramics FastDoor XL access doors where required by code. Sheet metal and insulation contractors shall coordinate installation of FastDoor XL.

2. Install 2 layers of Firewrap for a 2-hour commercial kitchen grease duct application per ASTM E 2336.

    a. General Installation Instructions for Double Layer Installations: The inside layer of Firewrap blankets are cut to a length that will fit around the duct and meet with a tight butt joint. Adjacent blankets on the inside layer are tightly butted against each other. The outside layer is cut to a length that will fit around the duct and overlap itself no less than 3 inches (152 mm). Adjacent blankets on the outside layer overlap each other a minimum of 3", or they can be fitted together with a tight butt joint and covered with a 6-inch (305 mm) wide collar centered

over the butt joint. Cut edges of the blanket shall be taped with aluminum foil tape to prevent exposed edges of the insulation from wicking of condensation moisture in air ventilation ducts or grease from a leaking grease duct joint. During installation the blankets are temporarily held in place with filament tape until the wrap is mechanically attached with steel bands or steel insulation pins.

3. Mechanical Fastening of Enclosure Material to Ductwork:

    a. Banding - Carbon steel or stainless steel banding is used to hold the outer layer of the blanket enclosure in place. Banding is minimum 1/2 inch (12.7 mm) wide and is placed around the entire perimeter of the duct on maximum 10-1/2 inches (267 mm) centers and 1-1/2 inches (38 mm) from each blanket or collar edge.
    b. Pinning - To prevent blanket sag on duct spans 24-inch wide (610 mm) or larger, minimum 12-gauge steel insulation pins are welded to the duct along bottom horizontal and outside vertical runs in columns spaced 12 inches (305 mm) apart, 6 to 12-inch (152 to 305 mm) from each edge and on 10-1/2 inches (267 mm) centers. Pins are also required 1 inch (25 mm) from the end of a duct and 1 inch (25 mm) from any edge near a 90° bend spaced 6-inch (152 mm) apart. Pins are locked in place with 1-1/2 inch (38 mm) diameter or 1-1/2 inch (38 mm) square galvanized steel speed clips or cup head pins. Pins are turned down or the excess cut off to eliminate sharp edges.

4. Grease Duct Access Door Installation:

    a. Install field fabricated doors per manufacturers' instructions and applicable building code reports and laboratory design listings.
    b. Prefabricated DuctMate F2-HT or DuctMate Ultimate doors may be installed per manufacturers' installation instructions and field insulated per Thermal Ceramics installation instructions, applicable building code reports and laboratory design listings.
    c. Install access openings at each change in direction and at intervals as required by code. Insulation cover system shall be tested and listed by UL (HNKT G18) to provide zero clearance to combustible construction and 2 –hour fire rating per ASTM E 2336. Duct access cover panel shall be tested and listed by UL (YYXS.MH47995) with integral neoprene gasket to provide liquid tight seal and shall have a high temperature gasket and signage "Access Door – Do not Obstruct" compliant to code and NFPA 96. Installation shall be performed by an experienced contractor per manufacturer instructions and applicable UL Listings. Sheet metal and insulation contractors shall coordinate installation of the FastDoor XL and the duct enclosure system.

5. Through-Penetration Firestop System:

    a. When the duct penetrates a concrete or dry wall fire rated floor, ceiling, or wall an approved firestop system shall be employed. Firewrap shall be installed directly to the duct through the penetration, or terminated on both sides of the penetration depending on the annular space allowance between the duct and the duct opening. When the Firewrap enclosure system is terminated on both sides of

the through penetration, the duct wrap material is mechanically attached to the duct at the termination points using either steel banding or steel pins.

b. To fire stop the through penetration void area, fill the annular space between the wrapped duct or bare duct and the periphery of the opening with scrap Firewrap firmly packed into the opening. Compress scrap blanket to percentage stated in the firestop listing for a minimum depth as specified in the firestop listing. Recess packing material below surface on both sides of walls or top side only for floors to the depth stated in the firestop listing. Seal over the packing material using an approved firestop sealant to a depth as stated in the firestop listing, flush with top side of a floor assembly and both sides of a wall assembly.

E. Repair Procedures:

1. Repair damaged Firewrap in accordance with manufacturer's instructions.
2. Remove damaged section by cutting the bands and removing the anchor clips holding it in place. Apply a new section of the same dimension ensuring the same overlap and installation method that existed previously. Cut edges and tears in the foil must be taped with aluminum tape to prevent the insulation from wicking moisture or grease.

F. Protection:

1. Protect installed products until completion of project.
2. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 230100, “Mechanical General Provisions,” apply to this Section.

1.2 WORK INCLUDED

A. A separate Commissioning Agent (the Architect/Engineer) will be engaged by the Owner to administer the commissioning.

B. The Contractor shall provide all commissioning services as outlined in this Section; perform all testing, measurements, and inspection outlined in the ‘Commissioning Plan”; and coordinate with the Commissioning Agent. A template Commissioning Plan is attached. The final plan will be written after the construction contract is underway.

C. The Systems to be commissioned include:

1. All HVAC and related systems

1.3 COMMISSIONING OBJECTIVES

A. To ensure that all building systems, subsystems, equipment, controls, and interfaces with other building systems are installed, tested, and are operating in compliance with Contract Documents and within the scope of design requirements.

B. To ensure that all system operation and maintenance personnel are properly instructed to effectively and efficiently operate and maintain the systems, subsystems, equipment, and controls, and that they will receive all required manuals and documentation.

C. The Commissioning Agent shall provide the following to the Contractor for implementation and execution.

1. Commissioning Plan: The Commissioning Agent shall prepare the Commissioning Plan in accordance with contents as specified herein.
2. Checklists and Test Forms: The Commissioning Agent shall prepare the Pre-Functional Checklists and Functional Performance Test Forms, specifically for this project, and edited to suit the equipment and systems installed.

3. Submittals:

a. The Contractor shall submit the following documents to the Commissioning Agent for review and inclusion in the Commissioning Plan.

i. Piping pressure and vacuum test reports
ii. Equipment startup reports
iii. DALT report
iv. TABs report
v. HVAC Water quality test report
vi. Prefunctional Checklists completed by the installing Foreman.
vii. O&M Manuals with warranties
viii. Training class agenda and schedule

b. Commissioning Report: The Commissioning Agent shall assemble the final Commissioning Report comprised of completed prefunctional and functional checklists, equipment startup test reports, etc. organized by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

1.4 REFERENCED STANDARDS

A. ASHRAE 90.1-2016, 6.7.2.4

B. NEBB, “Procedural Standards for Building Systems Commissioning.”

C. SMACNA, “HVAC Systems Commissioning Manual.”

1.5 COMMISSIONING TEAM

A. The Contractor shall designate team members from each of the following to participate in the Commissioning Process (both pre- and post-occupancy):

1. General Contractor
2. Mechanical Subcontractor (and HVAC startup technicians)
3. Electrical Subcontractor
4. Testing, Adjusting and Balancing (TAB) Subcontractor
5. Automatic Temperature Controls Subcontractor

B. The Owner shall designate a representative to participate in the Commissioning Process.

C. Each of the team member’s names shall be submitted in writing to the Commissioning Agent for inclusion in the Commissioning Plan.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 IMPLEMENTATION OF COMMISSIONING PLAN

A. Plan Submittal: After the start of construction, the Commissioning Agent shall provide the Commissioning Plan to the Contractor for implementation and execution. The Plan shall provide the scope of commissioning tasks to the appropriate parties. Typical elements of the Plan shall include the following:

1. Commissioning Agent's preparation of the Commissioning Test Schedule and distribution to the Contractor and Owner.
2. Commissioning Agent visits to the job site to observe installation activities.
3. Contractor's pre-startup verification and completion of the Pre-functional Checklists.
4. Contractor's submittal of equipment and systems startup verification to the Commissioning Agent.
5. Contractor's submittal of testing, adjusting, and balancing (TAB) reports to the Commissioning Agent.
6. Contractor's functional performance testing with the Commissioning Agent.
7. Contractor's completion of operating and maintenance manuals and submittal to the Commissioning Agent.
8. Contractor's operation and maintenance personnel instruction.
9. Commissioning Agent's preparation of the Final Commissioning Report and submission to Owner.
10. Owner acceptance

B. Equipment and Systems Startup:

1. Pre-startup Verification: Prior to startup of equipment and systems, the Contractor shall indicate on the pre-start checklists and Commissioning Agent shall observe and verify that all items have been substantially installed in accordance with the project Contract Documents, including all change orders. Verification of the basic installation testing of systems shall be performed by the Contractor and shall include:

a. Hydrostatic testing of hydronic piping systems
b. Cleaning, flushing, and venting of piping systems, including removal and cleaning of all strainers
c. Cleaning of equipment and systems of construction dirt and debris, including replacement of filters, and all items per the approved checklists

2. Startup Verification: The Contractor shall indicate on the startup checklists, and Commissioning Agent shall verify that all HVAC equipment, systems, and subsystems have been activated and operate substantially in accordance with Contract Documents, with all equipment, system, and electrical operating and safety devices checked and functional. The Contractor's work also includes but is not limited to:

a. Calibration and testing of all automatic temperature control devices and building automation systems.
b. Testing and verification of all interlocks and interfacing between HVAC equipment, systems, subsystems, and other building systems.
c. Completion of testing, adjusting, and balancing (TAB) work, including the rechecking of 10% of the measurements.

3. Startup Documentation: Completed startup checklists shall be filled out by the Contractor after startup verification of each HVAC system, subsystem or each item of HVAC equipment. Startup checklists used by the Contractor Technicians shall be neat and typed using standard formats appropriate for the equipment. At the request of the Owner, Contractor shall provide trend data demonstrating equipment has been started and is operating within design parameters.

4. Notification: The Commissioning Agent shall notify the Owner and Contractor when the startup verification has been completed and the HVAC functional performance testing can be started.

3.2 FUNCTIONAL PERFORMANCE TESTING

A. Purpose: Every item of equipment, all systems and subsystems, controls, and all related equipment shall be tested and evaluated for conformance to performance data in the Contract Documents. Included is conformance to:

1. Equipment input and output capacities.
2. Systems and subsystems flow and distribution performance.
3. Control system performance, accuracy, and adherence to sequences of operation.
4. Minimum or part load operations and performance.
5. Interface with other equipment and/or systems.

B. Equipment Testing: Equipment functional performance testing shall not begin until the following notification of completion has been given to the Owner by the Commissioning Agent.

1. Copies of the manufacturer’s equipment start up reports are submitted to the Engineer for review and approval.
2. Copies of the commissioning pre-start up and start up reports are submitted to the Engineer and Owner for review and approval.
3. Testing and balancing report is submitted to and approved by the Engineer.
4. Direct digital control graphic screen shots of all equipment are submitted for approval by Engineer and Commissioning Agent, showing each unit operating within design parameters and Owner-designated operating schedules. Screen shots must be visible to Owner on Owner’s front-end workstation when submitted.
5. Demonstrate through trend data successful operation of the HVAC systems for a period of not less than 2 weeks. Any alarms during this 14-day period will restart the 14-day run time, unless otherwise advised by Engineer or Commissioning Agent.

6. Functional performance test checklists developed by the Commissioning Agent shall be used by the Contractor to document the equipment functional performance tests. Each item of equipment will be functional performance tested by the Contractor and the results documented by the Contractor at full load (and under part load conditions where required by the Contract Documents). Operation under "abnormal and/or emergency conditions" shall be simulated by the Contractor for equipment and systems, and all safety equipment and control operations verified. Test methods shall be documented and approved by the Commissioning Agent prior to implementation and shall be covered during the Owner's training as well. No equipment test functions or procedures shall be eliminated from the functional performance test unless approved by the Commissioning Agent and the Owner.

C. Systems Testing: Functional performance testing shall not begin until all equipment and systems have had startup verification by the Contractor and notification of completion has been given to the Owner by the Commissioning Agent.

1. Functional performance test checklists to document system or subsystem functional performance tests.
2. The functional performance testing of systems by the Contractor shall begin after equipment and subsystems have been tested and documented 14-day alarm free operation. The system interlock and interface testing sequence shall depend on the system design, complexity, and other factors.
3. HVAC systems and subsystems shall be tested under full load conditions and under part load conditions by the Contractor.
4. Actual physical responses shall be observed. Reliance on control signals or other indicators is not acceptable.
5. Control component input and output signals shall be confirmed by the Contractor for correctness under all operating conditions.
6. At the end of the functional performance test procedures, every mode of each operation of a system, each piece of equipment, every item in the control sequence description, and every zone or subsystem shall be proven to operate by the Contractor as defined in the project Contract Documents.

D. Test Documentation: Functional performance test checklists developed by the Commissioning Agent shall be used by the Contractor to document the results of the functional performance testing process.

1. Testing verification shall be provided by signatures of responsible parties (the Contractor, Sub-Contractors, Commissioning Agent, and Owner's Representative) on the functional performance test checklists and equipment checklists.
2. Functional performance testing shall be performed by the Contractor, by members of the Commissioning Team as outlined, and approved by the Commissioning Plan.
3. All members shall remain on the Commissioning Team throughout the entire functional performance testing procedures. Substitutions shall be permitted only by written approval of the Commissioning Agent and Owner.

E. Test Failures: No system or subsystem shall be accepted until all items of equipment in the system have approved and verified functional performance test checklists.

1. When a functional performance test is not approved, the Contractor shall be directed to provide a written report to the Commissioning Agent listing the deficiencies causing the test failure, and the possible remedies to correct the deficiencies.
2. After all deficiencies have been corrected; the entire functional performance test for the equipment, system, or subsystem shall be repeated.
3. The Commissioning Agent will continue to monitor the actions to correct the equipment or system deficiencies until an acceptable functional performance test has been accomplished.

F. Deferred Tests: If any checklist or functional performance test cannot be completed for seasonal reasons, lack of occupancy, or for other reasons, a written report shall be sent by the Contractor to the Commissioning Agent indicating when the test will be scheduled.

1. If any checklist or functional performance test cannot be accomplished due to deficiencies outside the scope of the work, the deficiencies shall be resolved and corrected by the appropriate parties before completion of the commissioning process.

G. Control System Verification: The Control Contractor shall provide a field technician on site with a portable control access computer and related test equipment. The date and time of this control system verification testing shall be scheduled in advance with the Commissioning Agent. The field technician shall demonstrate to the Commissioning Agent the accuracy of each physical input point, and the response of each physical output point during each mode of operation identified in the Sequence of Controls.

H. A checklist shall be provided by the Contractor for each of the physical hardware points prior to this system verification demonstration, with all identification information and the physical location of each physical input/output device. For input sensors, this checklist shall be completed during the field test to indicate what the actual measured reading was during the verification, verses what the control system indicated it was. For output devices, this checklist shall indicate what the response actually was verses what it should have been for each mode of operation. Any defective control component shall be replaced, and any programming errors identified shall be corrected and re-demonstrated to the Commissioning Agent.

I. Every item of the systems listed in 1.2.B shall be functionally tested in the presence of the Commissioning Agent and Owners Representative by installing contractor and supplying vendor technical representative.

3.3 OPERATOR INSTRUCTION

A. During System Installation: Schedules and materials for the participation of the operation and maintenance personnel during the installation of the systems and equipment shall be implemented as per the Commissioning Plan or as indicated in the Contract Documents by the Contractor.

1. Operation and maintenance personnel instruction shall include:

a. An instruction agenda with objectives
b. Classroom sessions using Contract Documents (specifications, system drawings), shop drawings, sequence of operations, equipment installation and operation manuals, and audio-visual aids, etc.
c. "Factory specialist" presentations by representatives approved by the Commissioning Agent
d. Job site visits
e. Sign-in sheets to verify attendance
f. Video-taping of all sessions

B. During Commissioning: The Contractor shall prepare schedules and coordinate the training sessions with the parties involved.

1. Equipment and systems maintenance manuals and schedules should be provided along with other information not provided during the installation phase instruction sessions.

C. Turn-over Instruction: When the systems are ready to be turned over to the Owner, the Contractor shall schedule a final session for operation and maintenance personnel instruction. The following shall be included:

1. Attendance by the Commissioning Agent, installing contractors, major equipment suppliers, and all other interested parties
2. Review of all system and equipment operations
3. Additional hands-on instruction where requested by the Owner or Commissioning Agent
4. A question/answer discussion period

3.4 COMMISSIONING REPORT

A. The commissioning documentation shall be prepared by the Commissioning Agent and shall be organized into a format similar to the Commissioning Plan. All pages shall be numbered, a table of contents provided, and shall include the following information:

1. Commissioning Plan: Provide a copy of the Commissioning Plan.
2. TAB Reports: Contractor shall provide approved testing, adjusting, and balancing (TAB) reports for all HVAC systems being commissioned to the Commissioning Agent for inclusion in the Report.
3. Drawings: As-built shop drawings of equipment and systems, sequence of operations, and as-built Contract Documents as modified by change orders shall be provided by the Contractor to the Commissioning Agent for inclusion in the Report.
4. Startup Checklists: Provide all startup checklists and equipment startup reports, organized by systems and subsystems.
5. Functional Performance Tests: Functional performance test checklists for all equipment, systems, subsystems, interlocks, and system interfaces organized by systems and subsystems shall be provided by the Contractor to the Commissioning Agent for inclusion in the Report.
6. Operation and Maintenance Manuals: Copies of approved operation and maintenance manuals specified in the systems Contract Documents and/or in the Commissioning Plan

shall be provided by the Contractor to the Commissioning Agent for inclusion in the Report.

7. Video Tape: Copies as indicated in the Contract Documents shall be provided by the Contractor to the Commissioning Agent for inclusion in the Report.

3.5 ACCEPTANCE

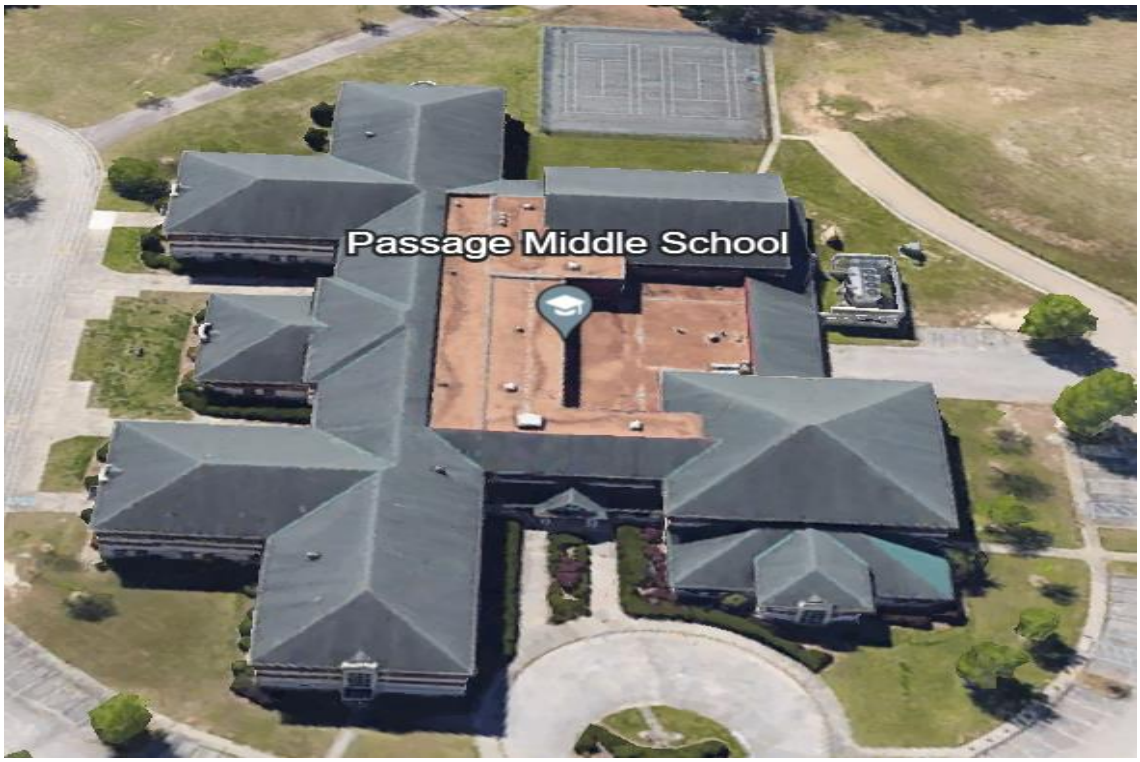
A. Documents to Owner: The Commissioning Agent shall be responsible for maintaining the commissioning documentation until Final Acceptance of the project. All checklists required by this Section shall become part of the commissioning documentation. The commissioning documentation shall be kept current and shall be available for inspection at all times. At the time of final acceptance of the project, the Commissioning Agent shall furnish copies of the commissioning documentation to the Owner and Contractor.

B. Warranties: All equipment and system guarantees and warranties specified in the Contract Documents shall be furnished to the Owner by the Contractor at the time of final acceptance of the project.

END OF SECTION 230800

NEWPORT NEWS PUBLIC SCHOOLS

COMMISSIONING PLAN
MARY PASSAGE MIDDLE SCHOOL



Project # 22-113

THOMPSON
Consulting Engineers
Mechanical and Electrical Engineering

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COMMISSIONING OVERVIEW

The purpose of this Commissioning Plan is to provide a clear and concise roadmap for the implementation of the commissioning process. The systems to be commissioned are identified in the Project Specifications.

This Commissioning Plan is a living document. The basic process and procedures for commissioning this project are detailed below. As the project develops appendices will be added to organize test reports, startup technician reports, issues logs, and completed checklists. Test documentation will be added throughout the construction project. At the end of the project the resulting compilation of information will become the Final Commissioning Report.

Integrating commissioning into a fast-moving construction project can be a challenge. The points below describe how our firm performs Commissioning.

- Commissioning begins during the design stage when our Commissioning Agent (CxA) reviews the project documents and makes comments to the designers. A Commissioning Plan is prepared for inclusion in the Bid Documents.

- After the construction contract is awarded and prior to the start of system rough-in, a Kick Off Meeting is held with the construction team. This will include the Project Managers and Foremen for the General, Mechanical, Electrical, TABs, and Controls Contractors; Equipment Representatives; and the Owner.

- The General Contractor (GC) is asked to maintain the Prefunctional Checklist. This document is a part of the Commissioning Plan and has a checklist for every unit on the drawing HVAC equipment schedule. The installing trade Foreman is asked to review the Prefunctional Checklist and confirm completion by initialing each item. When the Prefunctional Checklist is complete, the GC requests a CxA site visit.

- The GC is requested to not start HVAC equipment until receiving concurrence from the Engineer, CxA and Owner. Prior to granting concurrence, the CxA will confirm the Prefunctional Checklist is complete and discuss the building conditions with the GC. The goal being to prevent permanent damage to the equipment.

- Equipment startup is required to be performed by Factory Authorized technicians and documented on standardized report forms.

- After startup, the Test and Balance Contractor (TABs) may begin his work.

- The Design Engineer and CxA will review all startup and testing, adjusting, and balancing (TABs) reports.

- When the TABs report has been submitted and approved by the Design Engineer and the control system is complete; Functional Commissioning may begin.

- Functional Testing will include all specified modes of control and sequence of operation under full and part load. The performance of alarms will be checked.

- Typically, Functional Commissioning occurs between Substantial and Final Completion of the Project. As such, design weather conditions may not be available when the project has achieved Substantial Completion. To address this issue, we follow the following guidelines.

    - Refrigerant based systems which reject heat to the atmosphere can be properly verified only when near design conditions are present. For these systems, second season testing is sometimes required.

    - Gas and electric heating sources and geothermal water source heat pumps can typically be verified by measuring the temperature differential across the appliance. For cases when this is not possible, second season commissioning will be performed.

    - Equipment shall not be forced to operate in the cooling or heating mode other than through the raising or lowering of coil discharge or indoor space temperature setpoints.

    - If there is insufficient time to perform the functional testing during the construction period, seasonal commissioning may have to be performed the following year.

    - When the building must be occupied prior to Functional Commissioning, the testing occurs after normal hours for the occupants.

- The Engineer shall review all as-built record drawings, control drawings, and sequences of operation. Any changes to the electrical design to accommodate a substitute piece of equipment shall be reflected in the Record Drawings.

- The CxA or another member of Thompson Consulting Engineers will review the O&M manuals and Training Agenda.

- A Final Commissioning Report will be prepared and issued by the CxA along with a recommendation on Final Acceptance after all the Issues Log items have been resolved.

DESIGN PHASE

During the design phase, the CxA performs the following activities:

- Review and Modify Project Specifications
- Develop Initial Commissioning Plan
- Attend Pre-Bid Meeting (if requested)

Review and Modify Project Specifications

There are specific commissioning requirements located throughout the project specifications. During design, the CxA will review the specifications and suggest changes to the Design Engineer.

The specifications include the format in which contractor submittals will be presented, pressure testing of piping and duct systems, startup requirements, training requirements, system manual requirements, and so on.

The CxA will include the quality related items from the specifications in the commissioning checklists.

Develop Initial Commissioning Plan

The initial commissioning plan is similar to many other projects. It is intended to clarify individual roles and responsibilities relative to the commissioning process, identify the systems to be commissioned, and include a few typical commissioning checklists.

The commissioning plan will be distributed as a part of the project specifications.

Attend Pre-Bid Meeting

A representative of Thompson Consulting Engineering will attend the Pre-Bid Meeting, if requested.

CONSTRUCTION PHASE

During construction phase, the CxA tasks include:

- Attend the Pre-Construction Meeting (if requested).
- Conduct the Commissioning Kickoff Meeting.
- Back check Prefunctional Checklists maintained by the Installing Contractors.
- Monitor system startup
- Maintain and distribute the Issues Log.
- Conduct Functional Testing.
- Review the Owner Training Agenda.
- Review the Operation and Maintenance (O&M) manual.

Pre-Construction Meeting

Once the contractor is selected, the commissioning authority will attend and participate in the pre-construction meeting if requested. The role of CxA during the meeting will be to review and discuss the commissioning and the communication protocols the project team has developed.

Commissioning Kickoff Meeting

Prior to the start of Pre-Functional testing, the CxA will lead a kickoff meeting. This will include the Project Managers and Foremen for the General, Mechanical, Electrical, TABs, and Controls Contractors; Equipment Representatives; and the Owner.

The meeting will review the goals of commissioning, establish a schedule, and assign responsibilities to specific individuals. Once an individual is assigned to be a part of the commissioning team, they cannot be removed with out prior concurrence of the commissioning authority to preserve continuity.

Prefunctional Checklists

The Prefunctional Checklists are developed by the commissioning authority. They are to be completed by the General Contractor and Subcontractors. The intent of the checklists is to provide an organized method to verify the equipment is properly installed and requirements of the Project Documents are met.

System Startup

When the Prefunctional Checklists are complete, and the building cleanliness is adequate, equipment startup can proceed. The specifications contain specific requirements for startup. A field report for each unit is required to be submitted for review and inclusion in the final commissioning report.

Issues Log

The CxA will maintain an Issues Log to track items of concern. Each item will stay open until it is resolved; either by correcting the construction, demonstrating compliance as-is; or Owner acceptance.

Functional Testing

Functional testing occurs after all construction and startup is complete, the TABs report is approved by the Engineer, and DDC graphics are finished. A small team consisting of the CxA, Controls Technician, Mechanical Contractor, Equipment Startup Technicians, TABs Agent, and Owners Representative will exercise all the systems in the project scope.

Review Training

The CxA will review the contractor's submitted training agenda to ensure the specification requirements are covered and the contractor understands the expectations of training.

O&M Systems Manual

The Construction Administrator or the CxA will review the final manual for completeness and clarity.

Warranty Review

The Construction Administrator or CxA will review the warranty certificates provided by the Contractor.

CONTACT INFORMATION

Owners Representative
TO BE DETERMINED

Architect
TO BE DETERMINED

Mechanical Engineer
Kevin Allen
Thompson Consulting Engineers
22 Enterprise Parkway, Suite 120
Hampton, VA 23666
(757) 599-4415

General Contractor
TO BE DETERMINED

Mechanical Contractor
TO BE DETERMINED

Controls Contractor
TO BE DETERMINED

TABs Contractor
TO BE DETERMINED

SECTION 230885 - DUCT CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Construction Contract General Conditions, Contract Forms, other Division-l Specification Sections and Section 230100 “Mechanical General Provisions” apply to this Section.

1.2 APPLICABLE STANDARDS AND PUBLICATIONS

A. The following current standards and publications of the issues currently in effect form a part of this Specification to the extent indicated by any reference thereto:

1. National Air Duct Cleaners Association (NADCA): “Assessment, Cleaning & Restoration of HVAC Systems (ACR 2006),” 2006.
2. National Air Duct Cleaners Association (NADCA): “Understanding Microbial Contamination in HVAC Systems,” 1996.
3. National Air Duct Cleaners Association (NADCA): “Introduction to HVAC System Cleaning Services,” 2004.
4. National Air Duct Cleaners Association (NADCA): Standard 05 “Requirements for the Installation of Service Openings in HVAC Systems,” 2004.
5. Underwriters’ Laboratories (UL): UL Standard 181.
6. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62-89, "Ventilation for Acceptable Indoor Air Quality".
7. Environmental Protection Agency (EPA): "Building Air Quality," December 1991.
8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): “HVAC Duct Construction Standards - Metal and Flexible,” 1985.
9. North American Insulation Manufacturers Association (NAIMA): "Cleaning Fibrous Glass Insulated Air Duct Systems," 1993.

1.3 SPECIAL PROVISIONS

A. Qualification of the HVAC System Cleaning Contractor:

1. Membership: The HVAC system cleaning contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA), or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.
2. Certification: The HVAC system cleaning contractor shall have a minimum of one (1) Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.

3. Supervisor Qualifications: A person certified as an ASCS by NADCA, or maintaining an equivalent certification by a nationally recognized program and organization, shall be responsible for the total work herein specified.
4. Experience: The HVAC system cleaning contractor shall submit records of experience in the field of HVAC system cleaning as requested by the Engineer. Bids shall only be considered from firms which are regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.
5. Equipment, Materials and Labor: The HVAC system cleaning contractor shall possess and furnish all necessary equipment, materials and labor to adequately perform the specified services.

    a. The Contractor shall assure that its employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and Material Safety Data Sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by this Specification.
    b. The Contractor shall maintain a copy of all current MSDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs and this Specification.
    c. Contractor shall submit to the Engineer all MSDS for all chemical products proposed to be used in the cleaning process.

6. Licensing: The HVAC system cleaning contractor shall provide proof of maintaining the proper license(s), if any, as required to do work in this state. Contractor shall comply with all Federal, state and local rules, regulations, and licensing requirements.

1.4 STANDARDS

A. NADCA Standards: The HVAC system cleaning contractor shall perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).

B. All terms in this Specification shall have their meaning defined as stated in the NADCA Standards.

C. NADCA Standards must be followed with no modifications or deviations being allowed.

1.5 DOCUMENTS

A. Mechanical Drawings: The Contractor shall provide the HVAC system cleaning contractor with one copy of the following documents:

1. Project drawings and specifications.
2. Approved construction revisions pertaining to the HVAC system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCOPE OF WORK

A. The scope of this work applies to existing ductwork to remain and be re-used as part of the new systems.

B. This section defines the minimum requirements necessary to render HVAC components clean, and to verify the cleanliness through inspection and/or testing in accordance with items specified herein and applicable NADCA Standards.

C. The Contractor shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these Specifications.

D. The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire supply air ducts and supply diffusers and the return air ducts to the rooftop unit and return air grilles.

3.2 HVAC SYSTEM COMPONENT INSPECTIONS AND SITE PREPARATIONS

A. HVAC System Component Inspections: Prior to the commencement of any cleaning work, the HVAC system cleaning contractor shall perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment required to satisfactorily complete this project. The cleanliness inspection should include ductwork and associated diffusers and grilles.

B. The cleanliness inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, environmental engineering control measures should be implemented

C. Damaged system components found during the inspection shall be documented and brought to the attention of the Engineer.

D. Site Evaluation and Preparations: Contractor shall conduct a site evaluation, and establish a specific, coordinated plan which details how each area of the building will be protected during the various phases of the project.

E. Inspector Qualifications: Qualified personnel should perform the HVAC cleanliness inspection. At minimum, such personnel should have an understanding of HVAC system design, and experience in utilizing accepted indoor environmental sampling practices, current industry HVAC cleaning procedures, and applicable industry standards.

3.3 GENERAL HVAC SYSTEM CLEANING REQUIREMENTS

A. Containment: Debris removed during cleaning shall be collected and precautions must be taken to ensure that Debris is not otherwise dispersed outside the HVAC system during the cleaning process.

B. Particulate Collection: Where the Particulate Collection Equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the Particulate Collection Equipment is exhausting outside the building, Mechanical Cleaning operations shall be undertaken only with Particulate Collection Equipment in place, including adequate filtration to contain Debris removed from the HVAC system. When the Particulate Collection Equipment is exhausting outside the building, precautions shall be taken to locate the equipment down wind and away from all air intakes and other points of entry into the building.

C. Controlling Odors: Measures shall be employed to control odors and/or mist vapors during the cleaning process.

D. Component Cleaning: Cleaning methods shall be employed such that all HVAC system components must be Visibly Clean as defined in applicable standards (see NADCA Standards). Upon completion, all components must be returned to those settings recorded just prior to cleaning operations.

E. Service Openings: The Contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection.

F. Contractor shall utilize the existing service openings already installed in the HVAC system where possible.

G. Other openings shall be created where needed and they must be created so they can be sealed in accordance with industry codes and standards.

H. Closures must not significantly hinder, restrict, or alter the airflow within the system.

I. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.

J. Openings must not compromise the structural integrity of the system.

K. Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards.

L. All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location reported to the Architect in project report documents.

M. Air Distribution Devices (Registers, Grilles & Diffusers): The Contractor shall clean all air distribution devices.

N. Duct Systems: Contractor shall:

1. Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.
2. Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing Cleaning Verification Tests.

3.4 HEALTH AND SAFETY

A. Safety Standards: Cleaning contractors shall comply with applicable federal, state, and local requirements for protecting the safety of the contractor's employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this Specification.

B. Occupant Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.

C. Disposal of Debris: All Debris removed from the HVAC System shall be disposed of in accordance with applicable federal, state and local requirements.

3.5 MECHANICAL CLEANING METHODOLOGY

A. Removal Cleaning Methods: The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the Contractor's responsibility to select Source Removal methods that will render the HVAC system Visibly Clean and capable of passing cleaning verification methods and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

B. All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.

C. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet-vacuums.

D. All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection, including adequate filtration to contain Debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any outdoor environmental standards, codes, or regulations.

E. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those, which will not potentially damage the integrity of the ductwork, nor damage porous surface materials, such as liners inside the ductwork or system components.

F. Methods of Cleaning Fibrous Glass Insulated Components:

1. Fibrous glass thermal or acoustical insulation elements present in any ductwork shall be thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.

G. Cleaning methods used shall not cause damage to fibrous glass components and will render the system capable of passing Cleaning Verification Tests.

H. Damaged Fibrous Glass Material:

1. Evidence of Damage: If there is any evidence of damage, deterioration, delaminating, friable material, mold or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating, they shall be identified for replacement.
2. Replacement: When requested or specified, Contractor must be capable of remediating exposed damaged insulation in ductwork requiring replacement.
3. Replacement Material: In the event fiberglass materials must be replaced, all materials shall conform to applicable industry codes and standards, including those of UL and SMACNA.
4. Replacement of damaged insulation is not covered by this Specification.

3.6 CLEANLINESS VERIFICATION

A. General: Verification of HVAC System cleanliness will be determined after mechanical cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including biocidal agents and coatings.

B. Visual Inspection: The HVAC system shall be inspected visually to ensure that no visible contaminants are present.

C. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean; however, the Engineer reserves the right to further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA standards.

D. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

E. NADCA vacuum test analysis should be performed by a qualified third party experienced in testing of this nature.

3.7 PRE-EXISTING SYSTEM DAMAGE

A. Contractor is not responsible for problems resulting from prior inappropriate or careless cleaning techniques of others. Any such issues found shall be brought to the attention of the Engineer.

3.8 POST-PROJECT REPORT

A. At the conclusion of the project, the Contractor shall provide a report to the Engineer indicating the following:

1. Success of the cleaning project, as verified through visual inspection and/or gravimetric analysis.
2. Areas of the system found to be damaged and/or in need of repair.

END OF SECTION 230885

SECTION 230900 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, Section 230100, "Mechanical General Provisions," and Section 230500 "Heating, Ventilating, Air Conditioning" apply to this section.

B. Appendix A – Existing Controls Record Drawings

1.2 SYSTEM DESCRIPTION

A. Overview: NEWPORT NEWS PUBLIC SCHOOLS (NNPS) has standardized on the Tridium Niagara N4 (or later Tridium version) platform for its user interface and building controllers for all new and existing building control systems. The controls contractor shall provide new BACnet compatible controllers for all new and existing HVAC equipment at Mary Passage Middle School. All new and existing equipment controllers shall be integrated into the Tridium Niagara N4 system architecture for Mary Passage Middle School. The open protocol Direct Digital Controls (DDC) controllers provided by the controls contractor and/or the HVAC equipment manufacturers shall be connected to the Niagara N4 platform. The controls contractor is responsible for integrating new and existing controls at Mary Passage Middle School with the Niagara N4 supervising server located at NNPS plant.

B. Protocols: NNPS standard is to utilize BACnet protocol within the building control system. BACnet factory supplied onboard controllers shall be in their "native" open protocol, avoiding the need for gateways or translators. There may be some instances where a gateway or translator is the only method to integrate a controller, but those shall be submitted to and approved by the consultant engineer on a case-by-case basis.

C. DDC Controllers: The building control system will consist of DDC controllers that can stand-alone operate each piece of HVAC equipment (existing and new) or an HVAC system (existing and new) without the use of more than one (1) controller per equipment or system. The DDC controllers will be a combination of factory supplied controllers and control contractor provided and field installed controllers. The coordination of factory controllers vs. field controllers, sensors and integration will be the responsibility of the controls contractor to coordinate with the HVAC equipment providers. Reuse existing controllers where possible. Refer to Appendix A in this section for existing controls record drawings to be used as a basis of design.

D. Factory Installed Controllers: When a factory installed controller is provided with the HVAC equipment, the manufacturer is required to expose all functional and operational points within that controller to the open protocol communication port on the controller. This may require the manufacturers to create "shadow points" that mirror internal points within the onboard controller. The intent is not to display every point on the user interface graphics, but to ensure

that all points are accessible to the building control system. The controls contractor shall coordinate with the equipment supplier to ensure the hand-shake between the building control system and the factory supplied controller is 100% accurate and reliable information. The controls contractor shall be responsible for all field installation of sensors and control wiring for factory supplied controls.

E. Building Controllers: The controls contractor shall furnish and install Building Controllers to incorporate all the existing and new DDC controllers and factory controllers into one seamless harmonic building control system. The Building Controllers shall be based on the Niagara 4 Framework and "open licensed" so that any Niagara approved and qualified contractor can fully access and support the building control system. The controls contractor shall provide the number of DDC controllers needed to fully implement the sequence of operation, regardless of license pricing limitation thresholds.

F. Network Communication: NNPS will provide a network communication port in a local data closet. The controls contractor shall furnish & install a CAT5 communication cable from each Building Controller to the designated port on the IT switch. Additionally, the controls contractor shall provide NNPS with the Building Controller's MAC address and location identifier. The JACE passwords shall be provided by NNPS to the Contractor. There shall be no other passwords or access to the JACE other than as provided by NNPS.

G. Server: NNPS has an established and designated server that is running the Niagara N4 Framework. The server applications to be applied by the controls contractor for this project are as follows:

1. User Login Credentials: are synchronized via the NNPS Active Directory where access privileges are assigned by a designated staff person. The controls contractor shall review & incorporate these user privileges in the building control system as to prevent lower-level users from obtaining specific features that are above their level of authority. Note: these access groups & privileges are well defined on the server.
2. Point Mapping: Every point in the building control system shall be mapped to the server by the controls contractor.
3. Graphics: The control contractor will be responsible for developing and populating color graphics on the server for Mary Passage Middle School that are in accordance with NNPS standards.
4. Schedules: The control contractor will be responsible for linking existing schedules from the server to the appropriate areas of the school.
5. Trending: The control contractor will be responsible for mapping and archiving all trended points to the server with uploading to the server every 2 hours. NNPS will provide to the controls contractor the trend intervals for all point types.
6. Alarming: The control contractor will be responsible for developing "smart alarms" which are critical alarms that get transmitted via email and/or text message to designated NNPS staff. Note: the smart alarm schedule and distribution list is currently set up on the server.

H. User Interface: The controls contractor is not required to provide any user interface products such as computer workstations, laptop computers, notebook computers or panel mounted displays. NNPS will utilize its existing user interface products to access the building control system through the NNPS network.

I. Software Editing Tools:

1. The control contractor shall provide one (1) licensed copies of the Niagara Engineering Tool software required to program and modify the internal programming for the DDC controllers that are provided by the control contractor. Included shall be a detailed user manual on how to use the software tool.
2. In addition, each JACE shall have embedded work bench software to permit programing changes without the use of the above Niagara Engineering Tool.

J. The installation of the control system shall be performed under the direct supervision of the controls contractor including; shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation.

K. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project.

L. The controls contractor shall be responsible for all Building Automation Systems (BAS), temperature control, 120 volt and low-voltage control wiring for the mechanical system, including interlock wiring for non DDC controlled equipment, for a complete and operable system. Control wiring shall be done in accordance with the specifications, NNPS standard practices, and all local and national codes.

M. The controls contractor shall purchase three 5-year maintenance support agreements for a total of 15 years of coverage, to begin after the initial 18-month support agreement expires. The agreement ownership shall be transferred to Newport News Public Schools.

1.3 QUALITY ASSURANCE

A. The DDC system shall be designed and installed, commissioned and serviced by manufacturer / factory trained personnel. The controls contractor shall have an in-place support facility within 100 miles of the project site with technical staff, spare parts inventory and necessary test and diagnostic equipment.

B. The controls contractor shall provide a dedicated and experienced Tridium Niagara N4 certified project manager for this work, responsible for direct supervision of the installation, start up and commissioning of the building control system.

C. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

D. All Building Controllers and DDC controllers shall be UL Listed under Standard UL 916.

E. All programmers working in the N4 platform shall be Niagara 4 certified.

F. The Controls Contractor shall lead a coordination meeting between Major Equipment Suppliers, Mechanical Contractor, Electrical Contractor, General Contractor, Engineer and

Owner to plan the integration of manufacturer provided equipment level controllers into the control system. Every control point and startup responsibilities shall be reviewed for a smooth integration process. Meeting minutes shall be prepared and forwarded to participants by the Controls Contractor.

G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

H. The lead programmer shall operate the controls the entire duration of the Commissioning process.

1.4 WORK BY OTHERS

A. All control and power wiring required for temperature control system and all interlocking and accessory control wiring required for equipment installed under Division 23 Sections shall be installed by the Temperature Control Contractor. The Automatic Temperature Controls Contractor shall be responsible for providing circuit breakers and power wiring and conduit from electrical panels installed under Division 26 to Automatic Temperature Controls panels.

B. Wiring of all power feeds through all disconnect starters to electrical motor.

C. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer.

D. Wiring of any electrical sub-metering devices furnished by BAS manufacturer.

1.5 SUBMITTALS

A. Submit six complete sets of documentation in the following phased delivery schedule:

1. Equipment data cut sheets
2. System schematics, including:

    a. Sequence of operations
    b. Point names
    c. Point addresses
    d. Interface wiring diagrams
    e. Panel layouts
    f. System riser diagrams
    g. Auto-CAD compatible record drawings

B. Upon project completion, submit operation and maintenance manuals, consisting of the following:

1. Index sheet, listing contents in alphabetical order.
2. Manufacturer's equipment parts list of all functional components of the system.

3. Auto-CAD disk of system schematics, including wiring diagrams.
4. Description of sequence of operations.
5. As-Built interconnection wiring diagrams.
6. Operator's Manual.
7. Trunk cable schematic showing remote electronic panel locations and all trunk data.
8. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)
9. Conduit routing diagrams.
10. Backup Niagara logic files for all JACE and Drivers for this project.

C. Niagara 4 Technical Certification Program (TCP) certificate for all integrating and on-site programmers.

D. The input setup data for equipment manufacturer provided programmable controllers shall be included in the O&M manual or controls as-built documents. This may take the form of screen shots for each input screen for each controller.

1.6 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the DDC system for a period of one year after project acceptance.

B. The adjustment, required testing, and repair of the system includes all new computer equipment, transmission equipment and sensors and control devices.

C. The on-line support services shall allow the local Controls Contractor to remote-in over the customer’s LAN/WAN via secure connection to monitor and control the facility's DDC system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.

D. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the Controls Contractor shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that the problem is reported.

PART 2 - PRODUCTS

2.1 PRE-APPROVED CONTROL CONTRACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following pre-qualified manufacturers; NO SUBSTITUTIONS.

1. HONEYWELL: Controls preferred by licensed Authorized Control Integrator (ACI) contractor.

B. Pre-Approved Controls Contractors shall also have completed two projects of similar scope to the HVAC Replacement at Mary Passage Middle School. Upon request, contractor shall submit a summary of similar completed projects along with the contact information for an Owner's Representative who can serve as a reference.

C. No additional control contractors will be considered.

2.2 DDC EQUIPMENT

A. Operator Work Station: This project will utilize existing workstations owned and maintained by NNPS.

B. Server: This project will utilize an existing server and software applications owned and maintained by NNPS.

C. Building Controllers: Provide an adequate number of Building Controllers to achieve monitoring and control of all data points specified and necessary to satisfy the sequence of operation for all mechanical systems shown on the plans. Refer to Appendix A in this section for existing data points. Building Controllers shall be provided as required to accomplish the sequence of operation regardless of software licensing pricing limitations. Each Building Controller shall be connected to the NNPS network via Ethernet connection to an IT switch port located in a nearby data closet.

1. Building Controllers shall be suitable for the anticipated ambient conditions and mounted in dustproof enclosures and shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non-condensing.
2. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Memory: The Building Controls shall maintain all BIOS and programming information in the event of a power loss by utilizing EEEprom auto-save features.
4. Diagnostics: The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode and generate an alarm notification.
5. Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 Watts at 3 ft.
6. Automatic staggered restart of HVAC equipment after restoration of power with short cycle protection.

7. The Building Controllers shall provide the interface between the Server and the DDC Controllers and provide global supervisory control functions over the entire building

control system. It shall be capable of executing application control programs to provide:

a. Calendar functions
b. Scheduling
c. Trending
d. Alarm monitoring and routing
e. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization
f. Integration of open protocols for BACnet, LON and Modbus
g. Central Management functions for all DDC Controllers and integrated controllers.

8. Building Controllers must provide the following hardware features as a minimum:

a. One Ethernet Port – 10/100 Mbps
b. One RS-232 ports
c. Four RS-RS485 ports electrically isolated
d. One LonWorks Interface Port – 78KB FTT-10A with Weidmuller connector
e. Power supply 24 VAC or 24 VDC
f. Battery Backup
g. Real-time clock

9. Event Alarm Notification and Actions:

a. The Building Controller shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
b. The Building Controller shall be able to route any alarm condition to any defined user location via NNPS network.
c. Provide for the creation of a minimum of five (5) alarm classes for the purpose of routing types, Critical, Failure, Trouble, Override, and User-Defined.
d. Provide timed (schedule) routing of alarms by class, object, group, or node.
e. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
f. Control equipment and network failures shall be treated as alarms and annunciated.
g. Alarms shall be annunciated in any of the following manners as defined by the user:

1) Screen message text
2) Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
3) Day of week
4) Time of day
5) Recipient
6) Graphic with flashing alarm object(s)

h. The following shall be recorded by the Building Controller for each alarm:

1) Time and date
2) Location (building, floor, zone, office number, etc.)
3) Equipment (air handler #, access way, etc.)
4) Acknowledge time, date, and user who issued acknowledgement.
5) Number of occurrences since last acknowledgement.

i. Alarm actions may be initiated by user defined programmable objects created for that purpose.

j. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

k. A log of all alarms shall be maintained by the UNC and/or a server (if configured in the system) and shall be available for review by the user.

l. Provide a "query" feature to allow review of specific alarms by user defined parameters.

m. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

n. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

10. Data Collection and Storage

a. The Building Controller shall have the ability to collect data for any property of any object and store this data for future use.

b. The data collection shall be performed by log objects, resident in the Building Controller that shall have, at a minimum, the following configurable properties:

1) Designating the log as interval or deviation.
2) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
3) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4) For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
5) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

c. All log data shall be stored in a relational database in the UNC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.

d. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

e. All log data shall be available to the user in the following data formats:

1) HTML
2) XML
3) Plain Text
4) Comma or tab separated values

f. The Building Controller shall have the ability to archive its log data locally (to itself) and remotely to the server.

1) Archive on time of day
2) Archive on user-defined number of data stores in the log (buffer size)
3) Archive when log has reached its user-defined capacity of data stores
4) Provide ability to clear logs once archived

11. Audit Log:

a. Provide and maintain an Audit Log that tracks all activities performed in the Building Controller. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the Building Controller), to another Building Controller on the network, or to a server. For each log entry, provide the following data:

1) Time and date
2) User ID
3) Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

D. DDC Controllers: Modular, comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control applications and standard control applications. DDC Controllers shall be provided for; Packaged Rooftop Units, DOAS Units, Vert-WSHPs, Horz-WSHPs, the central plant pumping system, and other applications as shown on drawings or identified in the points list.

1. DDC Controllers shall monitor and/or control each input/output point; process information; and provide at least 50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, enthalpy calculation, counters, interlocks, ramps, drivers, schedules, calendars, OSS, compare, limit, curve fit, and alarms.
2. Capable of stand-alone mode control functions operate regardless of network status.
3. Have a local operator interface port for program download from portable workstation.
4. Shall communicate with the Building Controller using BACnet protocol.

2.3 CONTROL PANELS

A. Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor

mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

1. Fabricate panel's 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Power Supplies: Provide power supplies that have the line-voltage (120V) totally enclosed as to ensure Arch-Flash Compliance. Only low-voltage shall be exposed within any control panel.
4. Provide ON/OFF power switch with over-current protection for control power sources to each local panel.

2.4 SENSORS

A. Electronic Temperature Sensors: Vibration and corrosion resistant for wall, immersion, or duct mounting as required.

1. Resistance Temperature Detectors: Platinum, thermistor, or Balco.
   a. Accuracy: Plus or minus 0.2 percent at calibration point; thermistors shall have a maximum 5-year drift of no more than .225°F maximum error of no more than .36°F
   b. Wire: Twisted, shielded-pair cable
   c. Insertion Elements in Ducts: Single point, 6 inches long; use where not affected by temperature stratification or where ducts are smaller than 4 sq. ft.
   d. Averaging Elements in Ducts: 60 inches, long, flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches long, flexible for use where prone to temperature stratification or where ducts are larger than 16 sq. ft; length as required.
   e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches. All thermometers shall have a digital read-out.
   f. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

2. Humidity Sensors: Bulk polymer sensor element.

   a. Accuracy: 2 percent at 10-90% RH with linear output.
   b. Room Sensors: Range of 0 to 100 percent relative humidity
   c. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

3. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: +/- 1 percent of full scale with repeatability of 0.5 percent.
b. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.
c. Building Static-Pressure Range: -.1 to .1, -0.25 to 0.25, -.5 to .5, -1.0 to 1.0 IN WC., jumper selectable.

4. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

B. Equipment operation sensors as follows:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 IN WC.
2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

C. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
3. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.5 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action under all environmental conditions (temperature, low power voltage fluctuations, tight seal damper design, maximum air and water flow forces).

1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
3. Spring-Return Motors for Valves Larger than NPS 2-1/2": Size for running and breakaway torque of 150 in. x lbf.
4. Nonspring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Damper and Valve Actuators: Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper or valve

1. Coupling: V-bolt and V-shaped, toothed cradle.
2. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
3. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
4. Actuators shall have the ability to be tandem mounted.
5. All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
6. Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
7. Power Requirements (Modulating): Maximum 15 VA at 24V ac.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: -22°F to 140ºF.
10. Run Time: 200 seconds open, 40 seconds closed.
11. All actuators shall have a 5-year warranty.
12. Valves:

    a. Provide BRAY control valves.
    b. Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
    c. Valve and Actuators shall come from the factory fully assembled.
    d. Spring Return Manual Override shall come with a 10 Degree Valve Preload to assure tight close off.

2.6 CONTROL CABLE

A. Network communication cable shall be plenum rated CAT5.

B. BACnet communication cable shall be plenum rated and certified BACnet compatible.

C. Field device cable shall be plenum rated 18 gauge stranded, twisted-shielded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

B. The controls contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. The controls contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate, or if any discrepancies occur between the plans and the Contractor’s work and the plans and the work of others, the control

contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the Contractor's work with the work of others.

3.2 PROTECTION

A. The controls contractor shall protect all work and material from damage by its employees and/or subcontractors and shall be liable for all damage thus caused.

B. The controls contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted.

3.3 COORDINATION

A. Site:

1. The project coordination between trades is the responsibility of the prime contractor who is the one tier higher contractual partner, such as Mechanical Contractor, General Contractor, Construction Manager, Owner or Owner's representative as applicable.
2. The controls contractor shall follow prime contractor's job schedule and coordinate all project related activities through the prime contractor except otherwise agreed or in minor job site issues. Reasonable judgment shall be applied.
3. Where the work will be installed in close proximity to, or will interfere with, work of other trades, the controls contractor shall assist in working out space conditions to make a satisfactory adjustment.
4. If the controls contractor deviates from the job schedule and installs work without coordinating with other trades, so as to cause interference with work of other trades, the controls contractor shall make the necessary changes to correct the condition without extra charge.
5. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals:

1. Refer to the "Submittals" paragraph in PART 1 of this Specification for requirements.

C. Test and Balance:

1. The controls contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
2. The controls contractor shall provide training in the use of these tools. This training will be planned for a minimum of 2 hours.

D. Coordination with controls specified in other Sections or Divisions of this Specification include controls and control devices that are to be part of or interfaced to the control system specified in this Section. These controls shall be integrated into the system and coordinated by the controls contractor as follows:

1. Each supplier of controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this Section.
2. The controls contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other Sections or Divisions of this Specification.
3. The controls contractor is responsible for providing all controls described in the Contract Documents regardless of where within the Contract Documents these controls are described.

E. The controls contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the Contract Documents.

3.4 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

A. Controls contractor shall have a 6 Sigma certified (or equivalent certification) quality manager on staff to inspect the project execution and to enforce quality standards.

B. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in PART 1 of this Specification.

C. Controls contractor shall continually monitor the field installation for code compliance and quality of workmanship.

D. Controls contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

3.6 WIRING:

A. All control and interlock wiring shall comply with national and local electrical codes and Division 26 of this Specification. Where the requirements of this Section differ from those in Division 26, the requirements of this Section shall take precedence.

B. All NEC Class 1 (line voltage) wiring shall be UL-Listed in approved 3/4" conduit according to NEC and Division 26 requirements.

C. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub fused when required to meet Class 2 current limit.)

D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in conduit may be used provided that cables are UL-Listed for the intended application. For example, cables used in ceiling plenums shall be UL-Listed specifically for that purpose.

E. All wiring in mechanical, electrical, or service rooms, or where subject to mechanical damage, shall be installed in conduit.

F. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

G. Do not install control wiring in conduit containing line voltage.

H. Where plenum-rated cable is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.

I. Where plenum-rated cable is used without conduit, it shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical conduits, piping, or ceiling suspension systems.

J. All wire-to-device connections shall be made at a terminal block or wire nut. All wire-to-wire connections shall be at a terminal strip or wire nut.

K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Contractor shall provide step-down transformers or interposing relays.

M. All plenum-rated wiring shall be installed as continuous lengths, with no splices permitted between termination points.

N. All wiring in conduit shall be installed as continuous lengths, with no splices permitted between termination points or junction boxes.

O. Maintain fire rating at all penetrations. Install plenum wiring in sleeves where it passes through walls and floors.

P. Size and type of conduit and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

Q. Include one pull string in each conduit 3/4 in. or larger.

R. Control and status relays are to be located in designated enclosures only. These enclosures can include packaged equipment control panel enclosures unless they also contain Class 1 starters.

S. Conceal all conduit, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).

T. Secure conduit with conduit clamps fastened to the structure and spaced according to code requirements. Conduit and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.

U. Adhere to this Specification's Division 26 requirements where conduit crosses building expansion joints.

V. The controls contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

W. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal conduit less than 1/2-inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

X. Conduit must be adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING

A. The controls contractor shall adhere to the items listed in the "Wiring" paragraph in PART 3 of the Specification.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

C. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Controls contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.

G. All runs of communication wiring shall be un-spliced length when that length is commercially available.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 INSTALLATION OF SENSORS

A. General:

1. Install sensors in accordance with the manufacturer's recommendations.
2. Mount sensors rigidly and adequately for the environment within which the sensor operates.
3. Room temperature sensors shall be installed in existing junction boxes.
4. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
5. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the full face of the coil.

3.9 INSTRUMENTATION INSTALLED IN PIPING SYSTEMS

A. Actuators:

1. Electric/Electronic:

a. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.10 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1 cm (1/2 in.) letters on laminated plastic MARY PASSAGE MS Newport News Public Schools nameplates.

D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors with nameplates.

F. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

G. Identifiers shall match record documents.

3.11 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. Point Naming standard shall be agreed upon between Owner and Controls Contractor. Refer to "Submittals" in PART 1.

C. Operator Interface:

1. Standard graphics – Provide graphics for all mechanical systems and floor plans of the building. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points, such as setpoints.
2. Show Dashboard for all equipment on a "graphic" summary table. Provide dynamic information for each point shown.

3.12 CONTROL SYSTEM CHECKOUT AND TESTING

A. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets that shall be submitted prior to acceptance testing. Commissioning work that requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the Owner and Construction Manager to ensure systems are available when needed. Notify the operating personnel, in writing, of the testing schedule so that authorized personnel from the Owner and Construction Manager are present throughout the commissioning procedure.

B. Phase I – Field I/O Calibration and Commissioning:

1. Verify that each control panel has been installed according to plans, specifications, and approved shop drawings. Calibrate, test, and have signed off each control sensor and device. Commissioning to include, but not be limited to:

   a. Sensor accuracy at 10, 50 and 90% of range.
   b. Sensor range.
   c. Verify analog limit and binary alarm reporting.
   d. Point value reporting.
   e. Binary alarm and switch settings.
   f. Actuator and positioner spring ranges if pneumatic actuation is utilized.
   g. Fail safe operation on loss of control signal, pneumatic air, electric power, network communications, etc.

C. Phase II – System Commissioning:

1. Each DDC program shall be put on line and commissioned. The controls contractor shall, in the presence of the Owner and Construction Manager, demonstrate each programmed sequence of operation and compare the results, in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracy. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and re-tested.

D. Phase III – Integrated System Program Commissioning:

1. Tests shall include, but not be limited to:

   a. Data communication, both normal and failure modes.
   b. Fully loaded system response time.
   c. Impact of component failures on system performance and system operation.
   d. Time/Date changes.
   e. End of month/end of year operation.
   f. Season changeover.
   g. Global application programs and point sharing.
   h. System backup and reloading.
   i. System status displays.
   j. Diagnostic functions.
   k. Power failure routines.
   l. Battery backup.
   m. Testing of all electrical and HVAC systems with other division of work.

2. Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracy and the system performance does not degrade over time.

3. Using the commissioning test data sheets, the controls contractor shall demonstrate each point. The controls contractor shall also demonstrate 100% of the system functions. The controls contractor shall demonstrate all points and system functions until all devices and functions meet specification.
4. The controls contractor shall supply all instruments for testing. Instruments shall be turned over to the Owner after acceptance testing.
5. All test instruments shall be submitted for approval prior to their use in commissioning.

    a. Test Instrument Accuracy:

        1) Temperature: 1/4°F or 1/2% full scale, whichever is less.
        2) Pressure: High Pressure (PSI): 1/2 PSI or 1/2% full scale, whichever is less.
        3) Low Pressure: 1/2% of full scale (in w.c.).
        4) Electrical: 1/4% full scale.

6. After the above tests are complete and the system is demonstrated to be functioning as specified, a 30-day performance test period shall begin. If the system performs as specified throughout the test period, requiring only routine maintenance, the system shall be accepted. If the system fails during the test, and cannot be fully corrected within 8 hours, the Owner may request that performance tests be repeated.

3.13 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration:

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this Specification. These tests shall occur after the controls contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this Section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the “Control System Checkout and Testing” paragraph in PART 3 of this Specification. The Engineer will be present to observe and review these tests. The Engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in PART 1, “Submittals.” The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The controls contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation, including day, night, occupied, unoccupied, fire/ smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the controls contractor.
5. As each control input and output is checked, a log shall be completed showing the date,

technician's initials, and any corrective action taken or needed.

6. Demonstrate compliance with PART 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Additionally, the following items shall be demonstrated:
    a. DDC control loop response: The controls contractor shall supply trend data output in a graphical form showing the step response of each DDC control loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
    b. Optimum start/stop: The controls contractor shall supply a trend data output showing the capability of the algorithm. The change-of value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
    c. Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and electronic formats.
9. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The controls contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance:

1. All tests described in this Specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the controls contractor may be exempt from the completion requirements if stated as such, in writing, by the Engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in PART 1, "Submittals."

3.14 TRAINING:

A. The controls contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed. Factory employed/ certified instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 7:00 a.m. to 3:00 p.m. weekdays.

B. Provide a minimum combined 16 hours of on-site training / orientation session and classroom or on-line training session for personnel designated by the Owner. Coordinate training sessions with the owner.

3.15 MISCELLANEOUS

A. Air Purification System Plasma Detector: The DDC System shall connect to the dry-contacts of the manufacturers provided control relay on the duct mounted plasma detection device. The DDC system shall transmit an alarm to the DDC operator's workstation anytime the associated system fan is enabled and the plasma detector fails to detect ions in the airstream.

END OF SECTION 230900

SECTION 232533 - WATER TREATMENT AND FILTRATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section includes the following for hydronic systems:

1. Automatic chemical-feed equipment
2. Chemicals

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote-control, signaling power-limited circuits.

C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water.

D. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, installation diagrams, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Wall mounted chemical feed and bleed panels.
4. Chemical injection pumps.
5. Chemical-treatment test equipment.
6. Chemical material safety data sheets.
7. Inhibited propylene glycol.
8. Laser Particle Distribution (LPD) Water Analysis.
9. Spill containment.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For feed and bleed panels including sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

B. Laser Particle Distribution (LPD) Water Analyses.

C. Chemical service reports for each hydronic system.

D. Legionella test reports for open loop systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide and install all chemical, components and additional materials required to maintain proper water treatment in hydronic systems. The contents of this specification are written with the intention to control scale, corrosion and microbiological fouling and provide high quality water for high efficiency HVAC systems.

B. Provide and install temporary sub-micron filtration equipment. Sub-micron filtration should be provided for the duration of construction or a minimum of 90 days to ensure hydronic system is clean and free of TSS. Sub-micron filtration shall reduce TSS to the sub-micron level to reduce system fouling, clogged strainers, system down time, and prevent reduction in design efficiency.

C. Cooling tower side-stream filtration system is existing to remain.

2.2 OPEN LOOP SYSTEMS

A. Automatic chemical feed and bleed system to control scale, corrosion and microbiological fouling are existing to remain. The system’s connectivity and function shall remain as prior to construction.

2.3 TEMPORARY HYDRONIC SUB-MICRON FILTRATION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Waltz Engineered Sales Sub-Micron Filtration

B. The Hydronic Sub-Micron Filtration system shall be designed to filter water in open and closed HVAC hydronic loops. The filter system shall be installed in a side stream method to the hydronic

loops to allow the removal of suspended solids down to 0.45 micron nominal. The filters shall be fully automated to perform continuous filtration and backwash cycles based on pressure differential and/or time.

C. Nominal continuous 0.45 sub-micron multi-media for removal of suspended solids. Must use Cross-Radial Flow Technology (percolation filtration is not acceptable), maximizing contact between process water and the filter's media and not compressing the media with a direct downward force.

D. 16" filters are rated for 35 GPM filtrate capacity. Footprint dimension: 34" wide x 34" length x 65" height. Filter shall be mounted on a portable base.

E. Company supplying rental filtration shall have a minimum of 10 years' experience in sub-micron filtration rental.

F. Contractor shall hire a third-party sub-micron filtration specialist. Start filtration once the system is filled following the pre-clean process, and filter for a minimum of 90 days per system. Approved contractors listed below:

1. Waltz Engineered Sales Sub-Micron Filtration

G. Contractor must provide proof of sanitization proving filter has been properly sanitized to reduce system cross contamination risks.

H. Contact: Waltz Engineered Sales, Inc. (866) 829-0005.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Particle Distribution (LPD) Water Analysis: Filter supplier shall conduct two (2) LPD analyses for each filter to include an initial water sample from all hydronic water circulating loops at the filter inlet. At the end of the 90-day period, one (1) additional water sample will be taken from the filter inlet for performance evaluation. LPD analyses shall be conducted by an independent water analysis laboratory. Before filter is disconnected, contractor shall forward a copy of all documented results to the engineer for final review.

B. Perform an analysis of the domestic supply water on the project site to establish incoming water quality baseline.

3.2 TEMPORARY HYDRONIC SUB-MICRON FILTRATION INSTALLATION

A. Piping taps for the temporary filter shall be 1 1/2", with 1 1/2" ball valves for filter isolation. Taps shall be located at either 3:00 or 9:00 o'clock on either the supply or return header loop with a minimum distance of 6'– 0" apart. Unit shall be located within 20'-0" of piping taps. All piping

to and from filter shall be provided by contractor. Contractor shall coordinate filter taps and location.

B. Backwash Supply: Filter systems shall require city water for backwash at a minimum of 20 GPM at 30-100 PSIG. Piping for backwash shall be minimum 3/4" diameter.

C. Backwash Drain: Filter systems shall require minimum 1" diameter to nearest drain.

D. Electrical: Filter system shall operate at 120V/1ph/60HZ. Electrical cord shall be supplied for receptacle connection.

E. Temporary Filter shall have all necessary components to provide a working sub-micron filtration system on each system for a minimum of 90 days.

3.3 WATER TREATMENT SERVICE

A. One sole contractor shall be responsible for administering the cleaning, flushing, filtering, and complete water treatment process.

B. Following initial fill and leak test by mechanical contractor, water treatment contractor shall install pre-treatment cleaner for the removal of oil, dirt, and mill-scale from the construction process. Allow cleaner to circulate for 24-48 hours. Mechanical contractor shall operate all system isolation valves and coordinate with the controls contractor to ensure all legs of the hydronic system have been opened. All components shall be on-line with exception to the equipment utilizing flushing bypasses to prevent unit clogging during the startup and cleaning process.

C. After system has been circulated for the recommended amount of time, begin a running flush to remove the cleaner chemical from the system. Flush system until the pH of system is within 0.5 of the domestic water pH and 10% of the domestic conductivity.

D. Install corrosion inhibitor for all systems and maintain system parameters within the following limits:

1. Open Loop Systems:

Parameter	**Limit**
Total Hardness (ppm)	30-500
Alkalinity (ppm)	30-500
Chlorides (ppm)	Less than 200
Conductivity (μS/cm)	900-1400
pH	8.0-9.0
Legionella Counts	<0.2-1 CFU/ml
Phosphonate (ppm)	4-6

E. Install and start sub-micron filters on all hydronic systems and perform initial LPD Analyses.

F. The water treatment contractor shall make regular visits to the site during the first year's operation (once a month). A report containing findings and recommendations shall be submitted to the Owner following each visit.

G. Provide monthly legionella testing for all open tower systems beginning at start-up and for the duration of the contract. Tests shall utilize the quantitative direct fluorescent monoclonal antibody (DFA) test for 14 serogroups of Legionella pneumophila.

H. At project completion, provide water quality reports for each system. Provide reports for initial and final LPD analyses and all monthly legionella reports for open loop systems.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

END OF SECTION 232533

SECTION 260100 ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

A. This Section of the Specifications describes the material and installation procedures to be followed for furnishing and installing the electrical equipment and material as outlined and described on the contract drawings and as stated in this Division of the Specifications.

B. Where the word “Contractor” appears in this Division of the Specifications, it applies to the Contractor performing the electrical portion of the work, unless specifically indicated otherwise.

C. The Contractor shall install the systems as specified herein and indicated on the contract drawings and shall furnish all labor, material, tools, scaffolds, erection equipment, services and other items of expense as necessary as a part of this Contract. This Contract further includes placing the systems into operation and properly testing, adjusting, balancing and training the owner’s personnel on the use of all items of equipment as specified and as approved by the Engineer.

1.3 SUPERVISION

A. The Electrical Contractor shall have a competent and English speaking designated Supervisor who is a Certified Master Electrician on the job site at all times that any electrical work is being performed. This shall include all electrical work being accomplished by contractors who are subcontractors to the prime Electrical Contractor.

1.4 DRAWINGS

A. General arrangements of the necessary conduits, feeders, light fixtures, devices, panels, and equipment are indicated on the drawings in diagrammatic form only. Due to the scale of the drawings, offsets, fittings, and accessories may not be shown. Work indicated but having details omitted shall be provided complete to an operating condition with all fittings, wiring, and ancillary equipment and material as required. Where rearrangement is necessary, submit drawings of proposed changes for approval and coordinate and arrange work with consideration to the mechanical drawings and the existing building conditions and to the work of the various

other building trades. Equipment provided under this Division of the Specifications shall be installed in accordance with the recommendations of the equipment or material manufacturer.

1.5 COORDINATION

A. Coordinate the electrical work with the mechanical drawings and work in order to avoid omissions and to eliminate any interference. Report any discrepancies found, as soon as possible, after discovery, to the Engineer.

B. The contractor shall be responsible for coordinating with the Division 23 Contractor for providing properly sized circuit breakers to serve mechanical equipment and motors furnished which differ from that specified or indicated. This shall be further understood to include branch circuit wiring, conduit, disconnect switches, etc., in accordance with the appropriate codes and specifications. The cost of providing this increased electrical service and related work shall be included under the applicable section under which the equipment and motors are being furnished, at no additional cost to the Owner.

1.6 CODES AND STANDARDS

A. Various recognized codes and standards form a part of these Specifications the same as if written fully herein and shall be followed as minimum requirements. The codes and standards will be referred to by their abbreviated names and are listed below. Reference to these standards shall be understood to mean the latest edition and accumulative supplements which have been adopted by the "Authority Having Jurisdiction," unless noted otherwise.

ASAD	ADA Standards for Accessible Design
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CBMA	Certified Ballast Manufacturers Association
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IECC	International Energy Conservation Code
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
LEED	Leadership in Energy and Environmental Design
NEC 2017	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Prevention Association
NFPA 70E	Standard for Electrical Safety in the workplace
OSHA	The Occupational Safety and Health Act
UL	Underwriters Laboratories, Inc.
VUSBC	Virginia Uniform Statewide Building Code, 2018 Edition

B. All equipment, material, apparatus, and work shall conform to the requirements of the NEC. If the Contractor observes that the drawings and specifications are at variance therewith, the

contractor shall notify the Engineer in writing. If the Contractor performs such work contrary to the above referenced rules and regulations and without written acknowledgment or notice thereto, they shall correct this work and bear all cost arising therefrom.

1.7 NOTICES AND FEES

A. Give all required notices, obtain all necessary permits, and pay all required fees, including any fees associated with temporary electrical power services during construction. Utility company fees, which are for the permanent installation of electrical power services, shall be paid for by the Owner.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Refer to Specification 013300 “Submittals”, for shop drawing submittal procedures. Submit shop drawings for materials required for this project as indicated herein. Obtain approval from the Engineer before manufacture is started on any of same. The shop drawings shall show complete details of the various items, wiring diagrams, etc., and shall be submitted in a sufficient number of copies to allow the Engineer to retain one copy. Approved copies of all shop drawings shall be kept on the job site accessible to the Engineer at all times. All new power distribution equipment (switchboards, panelboards, disconnect switches, transformers, contactors, and other power-related components) shall all be by the same manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

A. The following list states specific names of acceptable manufacturers of particular equipment and indicates the types of material on which submittals shall be made:

	Submittal Information Required:
Light Fixtures	Product Data

See light fixture schedule on drawings.

NOTE: If substitute light fixtures are submitted for review, provide catalog data on the substitution which will provide all the information required to compare it to the specified product. At a minimum, provide dimensional and weight data, coefficients of utilization (CU) information, and photometrics for both the specified and substitute light fixtures.

Power Distribution Equipment
Panelboards..... Shop Drawings
General Electric / ABB Company
Square D Company
Eaton/Cutler-Hammer
Siemens

Disconnect Switches ..... Product Data
General Electric / ABB Company
Square D Company
Eaton/Cutler-Hammer
Siemens

Surge Protective Devices..... Product Data
Liebert
Square D
Eaton

Wiring Devices and Cover Plates ..... Product Data
Hubbell
Leviton
Arrow-Hart
Pass and Seymour

Dry-type Transformers ..... Product Data
General Electric / ABB Company
Square D Company
Eaton/Cutler-Hammer
Siemens

B. The following list states other materials for which product data submittals shall be made:

Circuit Breakers (each type)
Conductors (each type)
Conduit (each type)
Fire Alarm System Components
Fuses (each type)
Short Circuit Coordination Study and Arc Flash Hazard Analysis
Surface Metal Raceway (including all accessory components)
Infrared Scans of the Transformers and Panelboards.

C. Catalog numbers and manufacturers are listed as a guide for minimum requirements to be met. Material and equipment of manufacturers other than those listed will be given consideration by the Engineer providing the material meets the minimum requirements set forth in these Specifications and providing the material or equipment will provide satisfactory performance for the intended installation, does not exceed the dimensions and weight of the specified item and meets the aesthetic performance desired of the specified item. Submittals of other than specified equipment shall have indicated on the specification sheets in the shop drawing

submittals each item called for in these Specifications by paragraph and subparagraph numbers and/or letters.

D. Any deviation from the manufacturers listed in the preceding list and /or of those stated in the Contract Documents shall be submitted to the Engineer for approval in accordance with Specification Section 260500, "Materials and Methods." Facsimile transmission of data for review will not be accepted.

E. The Engineer will review for approval, only one substitute for each type of material specified in the Division 26 Contract Documents. If the substitute material is not approved, the Contractor shall provide the material by one of the specified manufacturers. Approval of substitute material is at the sole discretion of the Engineer and Owner, and the Contractor shall bear all costs arising therefrom, including any design fees if additional design effort is deemed prudent or necessary by the Engineer.

F. Only the types of materials specified herein are approved for use on this project. No other material types will be considered.

PART 3 - EXECUTION

3.1 INSTALLATION

A. "Provide," as used on the drawings and in these Specifications, shall mean furnish, install, connect, adjust, test, and place into operation, except where otherwise specifically stated in the contract documents.

B. Provide coordinated electrical systems, equipment, and material complete with auxiliaries and accessories as required for a complete and operable finished project.

C. Run all conduits concealed except where specifically indicated otherwise. Exposed conduit installation other than where indicated shall be approved by the Engineer and Owner prior to installation.

3.2 CLEANING AND PAINTING

A. Remove all dirt, trash, and oil from all raceways, boxes, fittings, cabinets, and panelboards.

B. Protect, to the satisfaction of the Engineer, all equipment provided against damage during construction. If damage does occur to any materials, refinish, repair, or replace the equipment or material as directed by the Engineer.

3.3 REPAIR OF EXISTING WORK

A. Repair of existing work, demolition, and modification of existing electrical distribution systems shall be performed as follows:

1. Workmanship: Lay out work in advance.

    a. Exercise care when cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces as necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings and materials or equipment damaged using skilled craftsmen of the appropriate trades.

2. Existing Concealed Wiring to be Removed:

    a. Existing concealed wiring to be removed shall be disconnected from its source. Remove conductors and cut conduits flush with concrete floors, and top openings with non-shrink grout. Where wood floors are encountered, remove conduit to below wood floor. Where conduit that passes through walls is removed, seal opening in wall with a material that is equal to the fire rating of the material the wall is constructed from.

3. Removal of Existing Electrical Distribution System:

    a. Removal of existing electrical distribution system equipment shall include equipment's associated wiring including conductors, cables, exposed conduit, surface metal raceways, boxes, fittings, etc., back to equipment’s source or as indicated on the electrical drawings.

4. Continuation of Service:

    a. Maintain continuity of existing circuits to remain. Existing circuits shall remain energized unless otherwise indicated. Circuits which are to remain but were disturbed during demolition shall have circuit wiring and power restored back to original condition as approved by the Engineer. Only materials specified for this project may be used to affect repairs.

3.4 EXCAVATION

A. All excavations shall be made to the proper depth to assure a firm foundation for the work.

3.5 RECORD DRAWINGS

A. Refer to Specification Section 017839 “Project Record Documents”.

3.6 OPERATION AND MAINTENANCE MANUALS

A. Refer to Specification Section 017823 “Operation and Maintenance Data”.

B. Provide operation and maintenance manuals for all equipment and systems specified in Division 26, according to the following specifications:

C. Format: Hardback, 3-ring style binder, with project name on front cover and end of binder.

Content:

1. Title sheet, with name of project, architect and engineer.
2. List of installing contractors and subcontractors, with the name, address and telephone number of each.
3. Table of Contents listing all materials enclosed.
4. Tab sheet dividers between types of equipment.
5. Operation, maintenance, and installation instructions from manufacturer for each piece of equipment or system.
6. Temperature Control Diagrams and equipment wiring diagrams.
7. Equipment Warranties:
    a. Testing and Balancing Report.

D. Submit one copy of manual to the Owner for review by the Engineer.

E. Furnish three hard copies of manual and a CD containing an electronic version of the Manual in PDF format to the Owner after completion of the Engineer's review.

The following list states materials for which Operation and Maintenance Data submittals shall be made:

Power Distribution Equipment (Panelboards, Dry Type Transformers, and Disconnect Switches)
Short-Circuit Coordination Study and Arc Flash Hazard Analysis
Infrared Scans of the Transformers and Panelboards
Surge Protective Devices

3.7 EQUIPMENT INVENTORY

A. Provide a complete equipment inventory for all Electrical Equipment listed below. Refer to Appendix A in this section for the required template. A separate form shall be provided for each new piece of equipment provided.

B. Prior to substantial completion, submit the equipment inventory forms for review. Once approved, include the forms in the operation and maintenance manual.

The following list states materials for which equipment inventory shall be made:

Power Distribution Equipment (Panelboards, Dry Type Transformers, and Disconnect Switches)
Surge Protective Devices

END OF SECTION 260100

SECTION 260500 - MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

A. Provide all labor, material, tools, scaffolds, erection equipment, services and supplies to fabricate, install, connect, adjust, test, and place in operation the electrical and other systems as called for in these Specifications and as indicated on the Contract Drawings.

B. Properly store and protect all material and equipment until installed.

C. All material and equipment shall be new and of the quality noted or specified. Material, equipment, and work of inferior quality will be rejected and shall be removed from the job site immediately upon rejection and replaced. Unacceptable work shall be removed and replaced. All replacement material and work shall be done at the Contractor expense. The Engineer will decide upon the quality of material and equipment furnished and of the work performed.

1.3 WARRANTIES

A. The Contractor shall provide the Owner with a one-year, unlimited material and labor warranty on all work accomplished and materials provided under Division 26, 28, including all components thereof except as otherwise noted herein or in other specifications. The warranty start date is the date of project "Substantial Completion" as determined by the Engineer. All warranties shall be submitted as part of the shop drawing submittals.

B. Electronic Fluorescent and HID Ballasts shall be free from defect in material and workmanship for a period of five (5) years from the date of project "Substantial Completion" as determined by the Engineer.

C. Electronic LED drivers shall be free from defect in material and workmanship for a period of five (5) years from the date of project "Substantial Completion" as determined by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Electrical material furnished under these Specifications shall be new and listed by UL and shall bear the UL label where labeling service is available for the type of material provided for this project.

2.2 RACEWAYS

A. Raceways shall be of the size indicated or as required by the NEC; whichever is the larger; except where larger conduits are specified on the Contract Drawings. Raceways shall be 1/2" minimum.

B. Raceways shall be provided for all electrical systems indicated on the drawings unless specifically indicated otherwise. Raceways shall be hot-dip galvanized rigid steel conduit (GRS), electrical metallic tubing (EMT), flexible steel conduit, or intermediate metallic conduit (IMC). Flexible steel conduit in kitchen areas, and outdoors shall be liquid tight. Schedule 40 PVC conduit may be used only below grade, under concrete slabs-on-grade and other locations where specifically indicated.

2.3 CONDUCTORS

A. Conductors shall be of the American Wire Gauge size indicated on the contract drawings or specified herein.

B. All conductors shall be copper. The use of Aluminum conductors is not permitted.

2.4 OUTLETS

A. Outlet and junction boxes shall be of one-piece galvanized construction of a type and size applicable for use in the location indicated on the contract drawings and as required by the NEC.

B. Locations of outlets for lighting, devices, power, and equipment are indicated on the contract drawings. Owing to the small scale of the drawings, it is not possible to indicate the exact location. Examine the mechanical drawings, and finish conditions and arrange work as required to meet such conditions to the approval of the Engineer.

C. Verify the exact swing of doors and locations of furniture and built-in cabinetry prior to installing outlets for switches and receptacles and make the necessary adjustments in location and mounting height of same to avoid conflicts at no additional cost. Coordinate outlets with change orders, addenda, and job site differences.

2.5 FUSES

A. All fuses shall be provided by the Electrical Contractor.

B. Fuses shall be as follows:

1. General: All fuses must carry the UL inspected label. All fuses shall be plainly marked with ampere rating, voltage rating, interrupting capacity when greater than 10,000 Amperes and current limiting where it applies, and the name of the trademark of the manufacturer.
2. Interrupting Capacity: Each fuse shall be capable of safely interrupting the maximum short-circuit current available at the point in the circuit where installed.
3. Coordination: Service fuses and the fuses installed in feeder circuits shall be coordinated to provide a selective system of over-current protection.

C. Main, feeder, and branch circuit fuses shall be as follows:

1. Circuits 0 to 600 amperes shall be protected by BUSSMANN Low-Peak, Limitron, or Fusetron (RK5, 200,000 I/C) Fuses rated as indicated on the drawings.
2. Circuits 601 to 6,000 amperes shall be protected by Type KRP-C HI-CAP current-limiting fuses.
3. Motor Circuits: All motors rated 480 volts or less shall be protected by dual-element fuses rated not in excess of 175% and not less than 125% of motor nameplate rating or as indicated. Larger motors as indicated on drawings where fuse gaps are larger than size required for proper rating of fuse, install “all-metal” fuse reducers.

2.6 LABELING

A. Label all disconnect switches, panelboards and transformers provided under Division 26 of these Specifications.

B. Labels shall be machine engraved, laminated, Bakelite, nameplate type. Labels shall have black faces with white letters.

C. Size of labels shall be based on the required lettering and lettering size. The following are the minimum requirements for each type of label:

1. Panelboards and Transformers: First line of label shall state name of panel as shown on the drawings. Second line shall state from where the panel is fed. Lettering shall be 3/8" high.

Example:	Panel L-100	Transformer TC-1
	Fed from MDS	Fed From Panel #1
	Circuit # _____	Circuit # _____
	Voltage _____	Voltage_____

2. HVAC equipment with integral disconnects shall be labeled on the outside of the equipment housing at the location of the disconnect in the same manner as Motor Controllers. The HVAC equipment shall be labeled in 1/4" high letters. First line shall

state the name of the equipment as it appears on the electrical drawings. Second line shall state from what panel the equipment is fed.

Example: Roof Top Unit No. RTU-2
Fed from Panel 100
Circuit # _____
Voltage _____

3. Disconnect Switches/Lighting Contactors/Time Clocks: Disconnect switches, lighting contactors and time clocks shall be labeled in 1/4" high letters. First line shall state what the switch/contactor is feeding. Second line shall state from which circuit and panel the switch/contactor/time clock is fed.

D. Circuit breakers serving Fire Alarm Control Panels shall be provided with a red, Bakelite nameplate with white letters attached to the panel adjacent to the circuit breaker.

E. Attach labels with a minimum of two rivets or sheet metal screws. Adhesive-backed labeling will not be accepted.

F. Workspace indication for all electrical equipment (Panelboards and Transformers): Provide 3" wide, 5 mil floor marking safety vinyl tape (striped black and yellow) to show working clearances in the direction of access to live parts. Working clearance around equipment shall not be less than those listed in the N.E.C, Article 110.26 for all voltages specified. Do not install at flush-mounted or surface mounted panelboards and similar equipment in finished spaces, unless directed by the owner.

2.7 PULL BOXES

A. Install pull boxes at all necessary points, whether indicated on the drawings or not, to prevent injury to conductor insulation or other damage that might result from pulling resistance or for other reasons necessary for proper installation. Minimum dimensions shall not be less than the NEC requirements and shall be increased if necessary for practical reasons or where required to fit the job condition.

B. Above grade pull boxes shall be constructed of galvanized sheet steel, code gauge, except that not less than 12-gauge shall be used for any box. Where boxes are used in connection with exposed conduit, plain covers attached to the box with a suitable number of countersunk flathead machine screws may be used.

C. All junction and pull box covers shall be labeled indicating the circuits contained therein in a manner that will prevent unintentional interference with circuits during testing and servicing. For example: "HE1-13." See Specification Section 260534 for additional labeling requirements.

2.8 DISCONNECT SWITCHES

A. Disconnect switches shall conform to governing industry NEMA standards. They shall be listed

by UL. Disconnect switches shall be NEMA standard HD, quick-make, quick-break type, and capable of being locked in the off position.

B. Where disconnect switches are indicated or required by the NEC to be weatherproof, furnish NEMA 3R enclosures. Furnish NEMA 4X enclosures in kitchen areas and other spaces where specifically indicated.

C. Arc Flash Warning Labels: Provide all disconnect switches provided by this project with Arc Flash warning labels on the exterior of the switch.

2.9 BRANCH CIRCUITS

A. The branch circuit wiring has been designed to utilize the advantages of multi-wire distribution and shall be installed substantially as indicated on the drawings. Major changes in the grouping or general routing of the branch circuits require prior approval in writing from the Architect/Engineer.

B. The number of conductors in each run of conduit is indicated on the drawings, but where there is a conflict between the number of wires indicated and the actual number required as determined by the functional requirements of the connected load, or where the number of wires was inadvertently omitted from the drawings, the correct number and size of wires as determined by the functional requirements of the connected load shall govern and be provided at no additional cost.

C. Where individual 120V or 277V homerun circuits are shown on the drawings, they may be combined as follows:

1. No more than three phase conductors plus three neutrals and one ground per conduit.
2. No two of the same phase conductor per conduit.
3. Provide 120V circuits with individual neutrals per circuit. Neutrals may not be shared.
4. Neutral sharing by 277V circuits is acceptable.

2.10 MOTOR AND CONTROLLER DISCONNECTING MEANS

A. Provide a disconnecting means for each motor, where indicated on the drawings. A circuit breaker in a panelboard, horsepower rated switch, or type specified under Article 430 and 440 of the NEC will be acceptable as a disconnecting means, if readily accessible and if located within sight of the motor and in compliance with all codes. A quick-make and quick-break general use tumbler or snap switch will be acceptable for capacities of 20 amperes or less and 300 volts and less, provided the ampere rating of the switch is at least double the rating of the equipment controlled. Switches of 30- to 400-ampere capacity shall be of the enclosed, quick-make and quick-break type, heavy duty, horsepower rated. Switches shall disconnect all ungrounded conductors and shall disconnect grounded conductors if required by the NEC or if called out on the drawings to do so. Switches shall be fusible type where indicated on the drawings.

2.11 CABLE TIES

A. Provide cable ties in the length required. Standard, indoor cable ties shall be 7.9 inches in length minimum, 0.19 inches in width and 0.47 inches thick. The tensile strength shall be 50 pounds minimum and the maximum bundle diameter shall be 2 inches. Standard cable ties shall be black in color. Plenum rated cable ties shall be 6 inches in length minimum, .075 inches in width and 0.1 inches thick. The tensile strength shall be 50 pounds minimum and the maximum bundle diameter shall be 1.5 inches. Plenum rated cable ties shall be maroon in color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install material in a first-class and workmanlike manner to the satisfaction of the Engineer.

END OF SECTION 260500

SECTION 260519 - CONDUCTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

A. Feeder and branch circuit wiring shall conform to the requirements of the NEC, and shall meet all relevant ASTM specifications.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer for a complete installation and for the application indicated. Provide copper conductors with a conductivity of not less than 98% at a temperature of 20°C (68°F).

B. Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by installer to comply with project's installation requirements, the NEC, and NEMA standards. Select from the following UL types those wires with construction features which fulfill project requirements:

1. Type RHH: For dry locations; max operating temperature 90°C (194°F). Insulation, heat-resistant rubber; outer covering, moisture-resistant, flame-retardant, nonmetallic covering; conductor, annealed copper, compressed stranded.
2. Type USE: Underground service entrance cable identified for underground use; max operating temperature 75°C (167°F). Insulation, abrasion, moisture- and heat-resistant, black vulcanized interlinked polyethylene (VIP^2); conductor, annealed copper, compressed stranded.
3. Type RHW: For dry and wet locations; max operating temperature 75°C (167°F). Insulation, heat-resistant rubber; outer covering, moisture-resistant, flame-retardant, nonmetallic covering; conductor, annealed copper, compressed stranded.
4. Type THWN or THHN: Max operating temperature not to exceed 90°C (194°F) (THHN) in dry locations, or 75°C (167°F) (THWN) in wet or dry locations. Insulation, flame-

retardant, moisture- and heat-resistant, thermoplastic; outer covering, nylon jacket; conductor, annealed copper.

5. Type XHHW: For dry and wet locations; max operating temperature 90°C (194°F) for dry locations, and 75°C (167°F) for wet locations. Insulation, flame-retardant, cross-linked synthetic polymer; conductor, annealed copper.

C. Service entrance conductors shall be Type XHHW, RHW, or THWN.

D. Direct buried conductors shall be Type USE.

E. Unless specified otherwise, power and lighting conductors shall be 600 volt, Type THWN/THHN, or XHHW.

F. Where light fixtures require 90°C (194°F) conductors, provide only conductors with 90°C (194°F) insulation.

G. Conductors shall be continuous from outlet to outlet with splices made only in pull boxes, junction boxes, and outlet boxes.

H. Do not use wire smaller than #12 AWG for power or lighting wiring.

I. Refer to other Division 26 specification sections for type and size of wiring for Class 1, 2, and 3 circuits (circuits under 120V).

J. Wiring sizes #12 and #10 AWG shall be solid. Larger sizes may be stranded.

K. Neutral conductors shall not be under sized.

L. Where the standard lug sizes on circuit breakers and the main lugs on a main lug only panelboard will not accept the conductor size specified, provide Burndy Compression Type “AYP” or “AYPO” HYPLUGS or approved equal.

PART 3 - EXECUTION

3.1 SPLICES

A. Splicing connectors must have a metal spring that is free to expand. The spring must be suitably coated to resist corrosion. Each connector size must be listed by UL for the intended purpose. The connectors must be suitably color coded to assure that the proper size is used on the wire combinations to be spliced. Each connector must be capable of withstanding 105°C ambient temperatures. The connectors must be compatible with all common rubber and thermoplastic wire insulations. They must also be capable of making copper-to-copper, copper-to-aluminum, and aluminum-to-aluminum splices. At the Contractor’s option, self-strapping electrical tap connectors may be used in wire size and voltage range of the connector. When tape is required for splices, SCOTCHBRAND No. 33, or approved equal, shall be used. Use the plastic tape on PVC and its copolymers and rubber-based pressure-sensitive adhesive. The tape must be

applicable at temperatures ranging from 0°F through 100°F without loss of physical or electrical properties. The tape must not crack, slip, or flag when exposed to various environments indoor or outdoor. The tape must also be compatible with all synthetic cable insulations as well as cable splicing compounds.

B. Make splices in conductors #8 AWG and larger with solderless connectors, with molded composition covers.

C. Connect conductor sizes #12 and #10 AWG with pre-insulated spring connectors rated at not less than 105°C. Connectors shall be UL approved for fixture and pressure work. Connectors shall be 3M CO. SCOTCHLOK, Type Y, R, and B, or approved equal.

D. Join or terminate conductors #8 AWG and larger with pressure-type copper connectors and properly tape.

E. All branch circuits, feeders, and control wiring or cables of any type shall be color coded to identify the voltage and phase. The color shall be integral with the Insulation for sizes #12, #10, and #8 AWG. Larger size wire and cable shall be color coded with a minimum 1/2" wide, colored, plastic tape strip. Place strips a minimum of 6" on center anywhere the conductors are accessible and visible. Wire and cable shall be color coded to match the existing color coding if an existing color code is present. If there is no existing color code, provide the following:

120/208-Volt System	**277/480-Volt System**
Phase A - black	Phase A - brown
Phase B - red	Phase B - orange
Phase C - blue	Phase C - yellow
Neutral - white	Neutral - gray
Ground - green	Ground - green

F. After all wiring is pulled and ready for operation but prior to placing systems in service, conduct insulation resistance tests in all feeder circuits. Measure the insulation resistance between conductors and between each conductor and ground. Make measurements with an instrument capable of making measurements at an applied potential of 500 Volts.

G. Take readings after the voltage has been applied for a minimum of one minute. The minimum insulation resistance for circuits of #12 AWG conductors shall be 1,000,000 ohms. For circuits of #10 AWG or larger conductor, a resistance based on the allowable ampacity of the conductor shall be as follows:

25 through 50 Amperes	250,000 ohms
51 through 100 Amperes	100,000 ohms
101 through 200 Amperes	50,000 ohms
201 through 400 Amperes	25,000 ohms
401 through 800 Amperes	12,000 ohms
Over 800 Amperes	5,000 ohms

H. Advise the Engineer if the color-coding provided by the utility company differs from that indicated above.

3.2 TEMPORARY WIRING

A. Temporary wiring is not specified nor governed by this Division of the Specifications.

END OF SECTION 260519

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

A. Provide grounding for conduits, motor frames, metal casings, receptacles, and solid neutral, and as required by NEC Article 250.

PART 2 - PRODUCTS

2.1 GROUND WIRE

A. Provide a green insulated ground wire, sized per the NEC, in all conduits, junction boxes, and pull boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Connect grounding conductors to the panelboard equipment ground bus and not to the panelboard neutral bus. Also connect grounding bushings to the ground bus. Connect the neutral bus only to the system neutral wire. Provide a bonding wire between the equipment ground bus and the neutral bus in the main distribution equipment only. The grounding system (conduit, cabinets, enclosures, and grounding conductors) and the grounded system (neutral conductors and service equipment ground) shall be separate and independent systems, except at the main distribution equipment.

B. Test resistance to ground and submit readings to the Engineer for review. Include the date and time of the test and the name of the individual performing the test.

END OF SECTION 260526

SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

A. Extent of supports, anchors, sleeves, and seals is indicated in other Division 26 Sections.

B. Types of supports, anchors, sleeves, and seals specified in this Section include the following:

C-clamps
I-beam clamps
One-hole conduit straps
Two-hole conduit straps
Round steel rods
Expansion anchors
Toggle bolts
Wall and floor seals
Minerallac Straps
2 Piece Strutt Straps
Slotted Channel
Cable Ties

C. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 26 Sections.

1.3 QUALITY ASSURANCE

A. Furnish supporting devices manufactured by firms regularly engaged in manufacture of supporting devices of types, sizes, and ratings required.

B. Comply with the requirements of the NEC, as applicable to construction and installation of electrical supporting devices.

C. Comply with applicable requirements of ANSI/NEMA FB1, "Fittings and Supports for Conduit and Cable Assemblies."

D. Comply with NECA “Standard of Installation” pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

E. Provide electrical components which are UL-Listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES

A. Provide supporting devices complying with manufacturer’s standard materials, design, and construction in accordance with published product information and as required for a complete installation, and as herein specified. Where more than one type of device meets indicated requirements, selection is installer’s option.

B. Provide supporting devices of types, sizes, and materials required, and having the following construction features:

1. Reducing Couplings: Steel rod reducing coupling, 1/2" by 5/8"; galvanized steel; approx. 16 pounds per 100 units.
2. C-Clamps: Galvanized steel; 1/2" rod size; approx. 70 pounds per 100 units.
3. I-Beam Clamps: Galvanized steel, 1-1/4" by 3/16" stock; 3/8" cross bolt; flange width 2"; approx. 52 pounds per 100 units.
4. One-hole Conduit Straps: For supporting metal conduit through 3/4" galvanized steel; approx. 7 pounds per 100 units.
5. Two-hole Conduit Straps: For supporting metal conduit above 3/4" galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
6. Hexagon Nuts: For 1/2" rod size; galvanized steel; approx. 4 pounds per 100 units.
7. Round Steel Rod: Galvanized steel; 1/4" dia.; approx. 12.2 pounds per 100 feet, 3/8" dia.; approx. 29.3 pounds per 100 feet, 1/2" dia.; approx. 67 pounds per 100 feet.
8. Offset Conduit Clamps: For supporting 2" rigid metal conduit; galvanized steel; approx. 200 pounds per 100 units.
9. 2-Piece strut strap, appropriate size, and type for type of conduit being installed. 1-piece straps are prohibited.
10. Minerallac straps sized appropriately for the conduit installed. Drilling out the attachment hole is prohibited. Use proper size hardware for attachment per the UL listing.
11. 7/8” and 1 3/4" slotted channel shall be sized appropriately per the manufacturer’s specifications for weight distribution. All feeder conduit racks shall be 1 3/4” minimum.
12. Cable ties shall be Type 2S and 21S. Install in accordance with Section 330.30(A) of the NEC.

C. Provide anchors of types, sizes, and materials required and having the following construction features:

1. Expansion Anchors: 1/2"; approx. 38 pounds per 100 units.
2. Toggle Bolts: Springhead; 3/16" by 4"; approx. 5 pounds per 100 units.
3. Concrete anchors: Anchors used for attaching 1/4" rod shall be Hangermate one-piece

Concrete screw with internal threads or equal. Follow manufacturers installation specifications for proper installation.

4. Concrete Anchors: Anchors used for attaching 3/8” and 1/2” rod shall Lok Bolt Sleeve anchor type Dewalt 05815S-PWR and 05825S-PWR or approved equal. Follow manufacturers technical Data for weight limitations and installation specifications for proper installation.
5. Drop-in type anchors shall be used only in vertical concrete walls. Hollow wall anchors shall be used in hollow CMU walls. Anchor shall be installed with manufacturer approved set tool.

D. Provide sleeves and seals of types, sizes, and materials required, and having the following construction features:

1. Provide factory-assembled, watertight wall and floor seals suitable for sealing around conduit, pipe or tubing passing through concrete floors and concrete block walls. Construct with steel sleeves, malleable-iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps and cap screws.

E. Provide U-channel strut system for supporting electrical equipment, 16-gauge hot-dip galvanized steel of sizes required; construct with 9/16" dia. holes, 8" o.c. on top surface, and with the following fittings which mate and match with U-channel:

Fixture hangers
Channel hangers
End caps
Beam clamps
Wiring stud
Rigid conduit clamps
Conduit hangers
U-bolts

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES

A. Install hangers, anchors, sleeves, and seals as indicated in accordance with manufacturer’s published instructions and with recognized industry practices to ensure supporting devices comply with the requirements of the NEC, NECA, and ANSI/NEMA for installation of supporting devices.

B. Coordinate with other electrical work, including outlet box, raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps, and attachments to support conduit and outlet boxes properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be

supported together on trapeze-type hangers where possible. Install supports with maximum spacings indicated.

D. Tighten sleeve seal nuts until sealing grommets have expanded to form watertight seal.

END OF SECTION 260529

SECTION 260533 - RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

A. Run all conduit concealed, except conduit may be run exposed in mechanical rooms, locations where specifically indicated, and spaces with exposed construction as approved by the Engineer.

B. Provide a conduit system complete with fittings and hangers as specified herein and as required by the NEC. Run all electrical wiring systems above 24 Volts in conduit unless specifically indicated otherwise.

C. Install conduit as a complete system without wiring and continuous from outlet to outlet and from fitting to fitting, mechanically and electrically connected to all boxes, fittings, and wireways, and grounded in accordance with the NEC.

D. Cap ends of all conduit promptly upon installation with plastic pipe caps. Caps shall remain until wiring is ready to be installed. Taping the ends of conduits is not acceptable.

E. Size conduit to equal or exceed the minimum requirements of the NEC (except where sizes are specifically indicated on the drawings and in these specifications).

F. Verify exact swing of doors, prior to installing conduit for switches. Coordinate switches with the Architect's plans, change orders, addenda, and job site differences and make the necessary adjustments to avoid conflicts at no additional cost.

G. Coordinate the routing of conduit with other trades to avoid conflicts with structural members, piping, ductwork, and other job site conditions.

H. When PVC conduit is used below grade, it shall be glued together in such a manner so as to make it watertight.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Minimum size conduit shall be 1/2". Use larger sizes as required by the NEC to accommodate the number and sizes of wires contained therein.

B. Conduit concealed in walls or above ceilings shall be rigid (GRS), electrical metallic tubing (EMT), or intermediate metallic conduit (IMC). Flexible conduit may be used above accessible ceilings only. Conduit installed below grade and under concrete floors and slabs shall be Schedule 40 PVC, unless otherwise indicated. Conduit run vertically through concrete shall be GRS or IMC starting at 6" below the bottom of the slab. Where conduits turn up inside a wall cavity, IMC and GRS may be converted to EMT at 6" above the top of the concrete slab. No portion of the conduit radius or elbow shall be within the concrete slab. All below grade conduit elbows shall be GRS type. The use of MC or BX cable is not permitted.

C. GRS, EMT and IMC shall be UL approved, hot-dip, high-strength, galvanized steel.

D. Rigid PVC conduit shall be Schedule 40 (or Schedule 80 if required by the NEC), extruded from high-grade PVC compound and shall be light gray in color. Rigid PVC conduit shall be UL approved for direct burial and concrete encasement.

E. Flexible conduit shall be galvanized, continuous spiral, single strip type. In areas subject to moisture (such as kitchens), and where specifically indicated, flexible conduit shall have a plastic covering in accordance with NEC Article 350. Fittings shall be standard UL approved with ground connector. Watertight connectors shall be used with plastic-covered conduit. All flexible conduit installed in kitchens shall be plastic covered. The maximum length for flexible conduit is 72" unless as otherwise indicated. . Liquid tight flexible metal conduit is prohibited where subject to physical damage and areas where ambient and conductor temperature exceed the approved operating temperature. Cable ties used to support LFMC shall be type 2S or 21S.

F. Conduit may not be run in the flutes of metal roof decking and may not be attached to any part of metal roof decking.

G. Bury conduit run below grade a minimum of 24" below finished grade or so the top of the conduit is 6" below the bottom of the concrete slab if run underneath concrete unless indicated or required to be deeper. Increase the burial depth as required so that no part of the conduit radius is within the concrete slab where conduits turn vertical. Coordinate conduit routings and depths with all other trades and any and all existing underground utilities.

H. Empty or spare conduits stub-ups shall be capped with a threaded cap.

I. In areas classified as hazardous, the conduit coupling shall be below concrete slab and a single section of GRS conduit may be installed up to 18” A.F.F. to accept the required seal fitting.

2.2 FITTINGS

A. All conduit entering or leaving panelboards, cabinets, outlet boxes, pull boxes, or junction boxes shall have lock nuts and bushings, except provide insulated throat connectors on EMT conduit 3/4" and 1". Rigid steel conduit shall have a lock nut both inside and outside of the

enclosure entered. Install bushings on the ends of IMC conduit and EMT conduit larger than 1". Insulating bushings shall be OZ Type A for GRS and IMC, and Type B for EMT. Conduit entering enclosures through concentric knockouts shall have grounding-type bushings with copper bond wire to enclosure.

B. Provide expansion fittings where conduits cross building expansion joints. Expansion fittings shall be OZ Type AX with OZ Type BJ bonding jumper. See Architectural drawings for location of expansion joints.

C. Fittings for rigid conduit shall be threaded type, except where IMC changes to EMT above floor slab, fittings shall be threadless type.

D. Fittings for EMT shall be UL-approved, steel set screw couplings.

E. Conduits entering service enclosures (panelboards, disconnect switches, switchboards, motor control centers, etc. used as service entrance equipment) shall be provided with specification grade, insulating, grounding type bushings. Grounding bushing shall be bonded together and bonded to the service grounding buss.

2.3 JUNCTION BOXES

A. Use junction boxes on exposed conduit work for changes in direction of conduit runs and breaking around beams and columns.

B. Furnish covers and gaskets with the junction boxes where installed in damp or wet locations.

C. Label all junction and pull box covers indicating the circuits contained therein in a manner that will prevent unintentional interference with circuits during testing and servicing. For example: “HE1-13.” See Specification Section 260534 for labeling requirements.

2.4 PIPE SLEEVES

A. Provide pipe sleeves where conduits larger than 2" pass through walls. Contractor shall be responsible for proper and permanent location. Conduit shall not be permitted to pass through footings, beams, or ribs, unless indicated and/or approved. Coordinate pipe sleeve locations with all other trades affected.

B. Install pipe sleeves and properly secure in place with grout where conduit passes through masonry or concrete and at all fire-rated assemblies. Pipe sleeves shall be of a sufficient diameter to provide approximately 1/4" clearance all around the conduit. Fill void between conduit and sleeve with mineral wool to prevent sound transmission. Pipe sleeves in foundation walls shall be cast iron, 2" larger in diameter than the conduit installed. Pipe sleeves in walls, floors, and partitions shall be Schedule 40 black steel pipe. Extend sleeves above floor at least 1", pack space around conduit with fireproof material, and make watertight. Pipe sleeves passing through firewalls, smoke partitions, fire partitions, or floors shall be sealed with a UL-rated system appropriate for the specified rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install conduit concealed in walls, below floor slabs, and above ceilings, except conduit may be run exposed in mechanical and electrical equipment rooms. Maintain a minimum clear distance of 6" from parallel runs of flues, steam, or hot water pipes. Do not run conduit horizontally in concrete slabs.

B. Use flexible conduit (minimum 18" in length, maximum 72" in length) for connections to all motors, dry-type transformers, water heaters, and any equipment subject to vibration.

C. Group conduit so it is uniformly spaced, where straight and at turns. Make bends and offsets (where unavoidable) with a hickey or bending machine.

D. Ream GRS and IMC conduit after threading to remove all burrs.

E. Securely fasten conduit to outlets, junction boxes, and pull boxes to affect firm electrical contact. Join conduit with approved couplings. Running threads are not allowed.

F. Exercise care to avoid condensation pockets in the installations. Keep conduit, fittings, and boxes free from foreign matter of any kind, before, during, and after installation.

G. Do not use EMT below grade, outdoors and in wet locations.

H. Support exposed runs of conduit in accordance with N.E.C. 342, 344, 348, 350 and 358 and parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings with right angle turns consisting of fittings or symmetrical bends. Support conduit within one foot of all changes in direction and on each side of the change.

I. Supports shall be wall brackets, trapeze, strap hanger, or pipe straps, secured to hollow masonry with toggle bolts or Hollow wall anchors; to brick and concrete with expansion Anchors; to metal surfaces with machine screws; and to wood with wood screws. Overhead conduits supported by threaded rod from concrete shall be those listed in the approved hanger specification and conform to the manufactures technical data and installation specifications.

J. Use explosive drive equipment to make connections where the use of this equipment is beneficial, and is subject to strict compliance with safety regulations and approved by the Owner.

K. Wooden plugs inserted in masonry and the use of nails as fastening media are prohibited.

L. Do not support conduit from lay in tile ceilings grids, ceiling grid hangers, or lay on ceiling tiles.

M. Prime conduit with a surface conditioner “GalvaGrip” or approved equal and paint to match the surface on which attached. Conduit installed in mechanical and electrical rooms need not be painted.

N. Install and support conduit from the underside of the upper chord in bar joist construction.

O. Do not support conduit from or attach outlet or junction boxes to metal roof decks.

P. Do not run conduit in the cavity of exterior walls between brick and CMU.

Q. Seal openings in floors where conduits penetrate vertically through with a clear silicon sealant to prevent liquids and insects from passing through.

R. Where conduits penetrate vertically through fire-rated floors, or walls seal the conduits with a UL-Listed, water-resistant firestop material with a rating equal to or greater than the rating of the penetrated floors.

S. Metal conduit installed in earth shall be painted with two coats of bitumastic paint.

T. All conduit runs entering the building from outdoors shall be sealed against moisture migration and condensation by filling with insulating type foam.

U. Single runs of conduit 1/2” to 1-1/2” in diameter shall be supported by 1/4” round galvanized rod. Single runs of conduit 2” and larger shall be supported by 3/8” round galvanized rod. Single tier conduit racks with conduit 1/2” to 1” and no greater than five shall be supported by 1/4” round galvanized rod. Single tier conduits racks 1-1/4” and larger shall be supported with 3/8” round galvanized rod. All conduit racks larger than a single tier shall be 1/2” minimum round galvanize rod. Conduit and conduit racks shall comply with the manufacturer’s supporting limitations.

END OF SECTION 260533

SECTION 260534 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, “Electrical General Provisions,” apply to this Section.

1.2 SCOPE OF WORK

A. Furnish and install all junction boxes of a type and size applicable for use in the location indicated on the drawings and where required by the NEC.

B. Exercise special care in the location of outlet and junction boxes in order that the hanging or recessing of light fixtures will not be obstructed by piping or ductwork installed by other trades. To this end, coordinate the work with representatives of the other trades involved and by reference to the mechanical drawings.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Outlet boxes shall be sheet steel, zinc coated, or cadmium plated.

B. Provide existing and new outlet boxes installed but not used, including data outlets, with blank coverplates matching those provided on adjacent outlets.

C. Size boxes as follows:

1. Switch and Receptacle Outlet Boxes: Provide single gang outlet boxes 1-1/2" deep unless required to be larger. Provide extra deep boxes where required.
2. Fixture Outlets in Ceiling: 4" octagonal, minimum. Where required to accommodate larger conduit or a larger number of wires: 4-11/16" by 2-1/8" deep.
3. One-piece multi-gang boxes for use where two or more switches or receptacles are located side by side: 2-1/8" deep. Sectionalized boxes will not be allowed.
4. Where larger size boxes are required or called for, they shall be similar in all other respects to the types specified above.

D. Light fixture outlet boxes, where fixtures are to be mounted on the box, shall have suitable studs and supports for carrying the weight of the fixture. Increase box depth, as required, for additional wires and conduits.

E. Boxes in new finished walls shall be flush mounted and have flush coverplates and proper type extension rings or plaster covers where required. Provide blank Series 302 stainless-steel coverplates on boxes not scheduled to receive coverplates of an otherwise specified type. coverplates on boxes not scheduled to receive coverplates of an otherwise specified type. If an extension ring is used to extend a junction box, one extension ring shall be used per box.

F. Provide boxes located above suspended ceilings with galvanized steel covers, with openings or knockouts as required for type of service.

G. Boxes installed in concrete construction shall be galvanized concrete type at all locations except where condulet or cast-iron boxes are required for watertight or vaportight outlets.

H. Boxes installed in the floor shall be as specified on the drawings and shall comply with the requirements indicated on the drawings. Provide brass carpet flanges where boxes are installed in carpeted areas.

2.2 PULL BOXES AND JUNCTION BOXES

A. Install pull boxes and junction boxes where required for changes in direction, at junction points, and where needed to facilitate wire pulling.

B. Size boxes in accordance with the requirements of the NEC.

C. Boxes shall be constructed of 12-gauge minimum hot-rolled sheet steel and shall be hot-dip galvanized inside and outside to match the conduit. Boxes shall have removable covers.

D. Label the front face of the cover on each box with indelible black marker indicating the number of each circuit contained in or running through the box. In areas where exposed construction is the final finished condition and conduit and junction boxes are called out to be painted, label the inside face of the covers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Check all door swings and coordinate with all furniture, built-in equipment, and cabinetry prior to roughing-in conduit and boxes for switches, receptacles, and auxiliary system devices. Make necessary adjustments in the location of same to avoid conflicts as approved by the Engineer and at no additional cost to the Owner.

B. Install all outlet boxes flush with wall or ceiling finish.

C. Mounting heights of outlets in tile or unplastered masonry shall be varied plus or minus to the nearest block joint so the bottom or top of the box rests on a block joint. Install outlet boxes in the same space at the same height above finished floor unless indicated or required to be otherwise.

D. Check the location of all wall outlets prior to roughing-in conduit to verify that the outlet will clear any wall fixtures, shelving, work tables, etc., that exist or will be installed. Make necessary adjustments in the location of wall outlets to avoid conflicts as approved by the Architect and at no additional cost to the Owner.

E. Prior to roughing-in conduit, coordinate with other trades and the Owner regarding all equipment requiring electrical connections. Required adjustments to the conduit and wire sizes shall be made at no additional cost.

F. Conduit installation shall be rigid and secure, and, where necessary, angle iron (1" by 1" by 1/4" or larger) shall be provided to facilitate adequate mounting.

G. Install electrical boxes and fittings in accordance with manufacturer's published instructions, applicable requirements of the NEC and NECA "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

H. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

I. Provide "weatherproof-while-in-use" rated outlet covers for interior and exterior locations exposed to weather or moisture.

J. Provide knockout closures to cap unused knockout holes where blanks have been removed in panel cans, terminal cabinet backboxes, junction boxes, outlet boxes and pull boxes.

K. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.

L. Do not install boxes back to back in walls. Provide not less than 6" (150 mm) separation. Thru-the-wall boxes may not be used.

M. Position recessed outlet boxes accurately to allow for surface finish thickness.

N. Set floor boxes level and flush with finish flooring material.

O. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached or solidly embed electrical boxes in concrete or masonry.

P. Subsequent to installation of boxes, protect boxes from construction debris and damage.

Q. Upon completion of installation work, properly ground all electrical boxes.

R. Do not mount boxes to metal roof decking.

END OF SECTION 260534

SECTION 262200 - DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, “Electrical General Provisions,” apply to this Section.

1.2 SCOPE OF WORK

A. Extent of transformer work is indicated by drawings and schedules.

B. Types of transformers specified in this Section include and K4 or K13-rated dry-type transformers.

C. Electrical wiring connections for transformers are specified in applicable Division 26 Sections.

1.3 QUALITY ASSURANCE

A. Comply with the requirements of the NEC, as applicable to installation and construction of electrical power distribution transformers.

B. Comply with applicable portions of NEMA TR1 and DOE 2016 minimum Standards for power distribution transformers.

C. Comply with applicable requirements of ANSI C57-Series pertaining to power distribution transformers.

D. Comply with requirements of NEMA ST20, “Dry-type Transformers for General Applications,”

E. Comply with applicable requirements of ANSI/UL 506, “Safety Standard for Specialty Transformers.” Provide power distribution transformers and components which are UL-Listed and labeled.

F. Comply with applicable requirements of NESC (ANSI C2) pertaining to indoor and outdoor installation of transformers.

PART 2 - PRODUCTS

2.1 POWER DISTRIBUTION TRANSFORMERS

A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation. All transformers shall be products of a single manufacturer.

B. Dry-type Distribution Transformers: Provide factory-assembled, general-purpose, DOE 2016 compliant and K4 or K13 rated, air-cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated; 3-phase; 60 Hz, 30kV BIL, 4.0% nominal impedance, copper windings, with 480-Volts delta connection primary and 208/120-Volts secondary wye connected. Provide primary winding with six 2-1/2% taps; two above and four below primary rated voltage. Transformers 15kVA and above shall be rated for 150°C temperature rise above 40°C ambient except K4 or K13 rated transformers shall be rated for 115°C temperature rise above 40°C ambient. All insulating materials shall be in accordance with NEMA ST20 Standard for a 220°C UL component recognized insulation system. Limit transformer surface temperature rise to maximum of 65°C. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Provide wiring connectors suitable for copper wiring. Sound levels shall not exceed the following: 15 to 50kVA = 45 dB; 51 to 150kVA = 50 dB; 151 to 300kVA = 55 dB; 301 to 500kVA = 60 dB. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards. Provide transformers with fully enclosed sheet-steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for floor or wall mounting as indicated. The transformers shall be listed by UL for the specified temperature rise.

C. Provide transformers with weatherproof enclosures, whether indicated or not, when installed outdoors.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which power distribution transformers and ancillary equipment are to be installed and notify the General Contractor, in writing, of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TRANSFORMERS

A. Install transformers as indicated, complying with manufacturer's published instructions (including rear ventilation clearances), applicable requirements of the NEC, NESC, NEMA, ANSI, DOE and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

C. Connect transformer units to electrical wiring system; comply with requirements of other Division 26 Sections.

D. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

E. Provide 4" thick concrete housekeeping pad under all transformers. Exceed dimensions of transformer by 6" on all sides. Chamfer all exposed edges 1/2".

F. Keep transformers clean and free from foreign matter of any kind, before, during, and after installation.

G. Provide sufficient space around transformer for cooling as recommended by the manufacturer. Provide a minimum space of 8" between the transformer and any wall.

3.3 GROUNDING

A. Provide equipment grounding connections for power distribution transformers as indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

3.4 TESTING

A. Prior to energization of transformers, check all accessible connections for compliance with manufacturer's torque tightening specifications.

B. Prior to energization, check circuitry for electrical continuity and for short-circuits. After all wiring is pulled and ready for operation but prior to placing systems in service, conduct insulation resistance tests in all feeder circuits. Measure the insulation resistance between conductors and between each conductor and ground. Make measurements with an instrument capable of making measurements at an applied potential of 500 Volts.

C. Upon completion of installation of transformers, energize primary circuitry at rated voltage and frequency from normal power source and test transformers, including but not limited to audible

sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units or components and proceed with retesting.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days from Final Acceptance, perform an infrared scan of each transformer.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies transformer checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

A. Extent of panelboard, load center, and enclosure work, including cabinets and cutout boxes, is indicated by drawings and schedules.

B. Refer to other Division 26 Sections for cable/wire, connectors, and electrical raceway work required in conjunction with panelboards and enclosures; not work of this Section.

1.3 QUALITY ASSURANCE

A. Comply with the requirements of the NEC, as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with the NEC requirements pertaining to installation of wiring and equipment in hazardous locations.

B. Comply with applicable requirements of UL 67, "Electric Panelboards," and UL 50, UL 869, UL 486A, UL 486B, and UL 1053 pertaining to panelboards, accessories, and enclosures. Provide units which are UL-Listed and labeled.

C. Comply with NEMA 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," and NEMA PB1, "Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less."

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with the NEC, UL, and established industry standards for

those applications indicated. Series rating is not acceptable for circuit breakers serving life safety equipment.

B. Provide dead-front, safety-type, power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types, and arrangement shown; with mechanical type conductor connectors for Main, Neutral, and Ground lugs approve for copper or aluminum conductors. Specific circuit breaker placement is required in panelboards to match the circuit breaker placement indicated in the panelboard schedule on the drawings. Equip with copper busbars with not less than 98% conductivity and with neutral bus. Provide all 208Y/120 volt panelboards served by K4 or K13 rated transformers with 200% neutral bus. Provide suitable lugs on neutral bus for outgoing circuits requiring neutral connections. Provide bolt-on molded-case main and branch circuit breaker types for each circuit, with toggle handles that indicate when tripped. Where multiple-pole circuit breakers are indicated, provide with common trip so an overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate properly with panelboards. Branch mounted main circuit breakers are not acceptable. Provide bottom mounted main circuit breakers for panelboards fed from below. Provide top mounted main circuit breakers for panelboards fed from above. All spaces shall have bus fully extended and drilled for the future installation of breakers.

C. Provide galvanized sheet-steel cabinet-type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush locks and keys. All panelboard enclosures shall be keyed alike. Equip with interior circuit directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for flush mounting unless otherwise indicated. Provide enclosures which mate properly with panelboards to be enclosed.

D. Provide panelboard accessories and devices, including but not necessarily limited to circuit breakers and ground-fault protection units, as recommended by panelboard manufacturer for ratings and applications indicated. Circuit breakers serving permanently connected appliances rated over 300 volt-amperes shall be capable of being locked in the “OFF” position. Circuit breakers serving surge protective devices “SPD” shall be located close to the equipment main circuit breaker or main lugs whether indicated or not. Provide HACR rated circuit breakers for all heating and air conditioning equipment.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which panelboards and enclosures are to be installed, and notify the General Contractor, in writing, of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Install panelboards and enclosures as indicated, in accordance with manufacturer's published instructions, applicable requirements of the NEC and NECA "Standard of Installation," and in compliance with recognized industry practices to ensure that products fulfill requirements.

C. Coordinate installation of panelboards and enclosures with raceway installation work.

D. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

E. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

F. Provide properly wired electrical connections within enclosures.

G. Provide a typed circuit index card for each panelboard upon completion of installation work. Indicate load served and room number(s). Use final room numbers obtained from the Architect or Owner, not construction room numbers as shown on the drawings.

3.2 GROUNDING

A. Provide equipment grounding connections for all panelboards. Tighten connections to comply with tightening torques specified in UL 486A and UL 486B to assure permanent and effective grounding.

3.3 FIELD QUALITY CONTROL

A. Keep panelboards clean and free from foreign matter of any kind, before, during, and after installation.

B. Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.

C. Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

D. Prior to energization, check panelboards for electrical continuity of circuits and for short-circuits.

E. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days from Final Acceptance, perform an infrared scan of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 GROUND FAULT EQUIPMENT TESTING

A. Ground fault equipment provided with panelboards shall be tested when first installed on the site in accordance with the requirements of NEC Article 230.95.

B. A written record of the test shall be made available to the authority having jurisdiction.

END OF SECTION 262416

SECTION 262420 - MOTORS AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

A. Furnish and install disconnect switches as indicated on the drawings and specified herein.

B. Provide all power wiring, disconnect switches and electrical connections to all equipment provided and requiring electrical connections. Starters and/or magnetic contactors; including Variable Frequency Drives ("VFD") for HVAC equipment that is not integral with the HVAC equipment; shall be furnished by Division 23 Contractor, installed where and as indicated on the electrical drawings by the Electrical Contractor and provided with power wiring by the Electrical Contractor unless otherwise indicated. Power wiring between magnetic contactors and the final connection point on the HVAC equipment shall be provided under Division 26. Division 23 Contractor shall provide the proper number and size of auxiliary contacts in the magnetic contactors required for the proper operation and control of the HVAC equipment.

C. All control wiring and conduits between control instruments and the magnetic contactor or VFD serving a piece of mechanical equipment shall be provided by Division 23 Contractor and installed in accordance with the requirements of Division 26, unless otherwise indicated on the electrical drawings or in the electrical specifications.

D. Review the mechanical drawings and specification sections for exhaust fans requiring control by wall switch, solid state speed controller, or line voltage thermostat and provide same where indicated on the electrical drawings.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

A. Disconnect switches shall be rated for the voltage of the equipment being served with number of poles and current rating as indicated. Disconnect switches shall be non-fusible or fusible type as indicated on the drawings.

B. Switches shall be NEMA standard Heavy Duty type.

C. Switches shall be horsepower rated when used for motor disconnect means.

D. Provide fused disconnect switches complete with appropriately sized fuses for the circuits controlled.

PART 3 - EXECUTION

3.1 INSTALLATION OF DISCONNECT SWITCHES

A. Examine area and conditions under which electrical connections for equipment are to be installed. Notify the General Contractor; in writing; of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Coordinate locations of disconnect switches with the locations of mechanical equipment, piping, electrical equipment and any and all other building elements such that all NEC requirements, including working clearances, are met. Adjust locations from those shown on the drawings as required to comply with NEC working clearance requirements at no additional cost to the project.

C. Secure disconnects switches to building elements or equipment housings where indicated on the drawings. Where building walls or equipment housings do not provide suitable mounting surfaces, provide a galvanized unistrut frame or rack satisfactory in size to securely support the disconnect switch, magnetic contactor and /or VFD. Where racks are required to be roof mounted, secure the rack to the roof in a method that does not compromise the roof membrane in any way. Submit the roof attachment method to the Engineer for approval prior to construction or installation.

3.2 ELECTRICAL CONNECTIONS TO EQUIPMENT

A. Provide electrical connections to equipment indicated in accordance with equipment manufacturer’s published instructions and recognized industry practices. Comply with applicable requirements of UL, the NEC and the NECA “Standard of Installation,” to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/cables, raceway and equipment installation as necessary to properly interface installation of electrical connections to equipment with other work.

C. Connect electrical power supply conductors to equipment in accordance with equipment manufacturer’s published instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Cover splices with electrical insulating material equivalent to or greater than the electrical insulation rating of the conductors being spliced.

E. Prepare cables and wires by cutting and stripping covering, armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Avoid “ringing” conductors while skinning wire.

F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer’s torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL 486A.

H. Provide flexible steel conduit for motor connections and other electrical equipment connections where subject to movement and vibration.

I. Provide liquid-tight flexible steel conduit for connection of motors and other electrical equipment where subject to movement and vibration and where connections are located where subject to any of the following conditions:

1. All exterior locations
2. Moist or humid atmosphere where condensation can be expected to accumulate (Example: sump pump and elevator pits)
3. Corrosive atmosphere (Example: battery charging rooms)
4. Water spray
5. Dripping oil, grease, or water
6. Kitchens and Sculleries

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 262420

SECTION 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings.

1.2 RELATED SECTIONS

A. Section 262416 – Panelboards

1.3 REFERENCES

A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 latest addition).

1.4 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:

1. Provide verification that the SPD complies with the required ANSI/UL 1449 Latest Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
2. Electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

B. Where applicable the following additional information shall be submitted to the engineer:

1. Descriptive bulletins
2. Product sheets

1.5 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 - PRODUCTS

2.1 VOLTAGE SURGE SUPPRESSION – GENERAL

A. Electrical Requirements:

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.
6. ANSI/UL 1449 Latest Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 Latest Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277
L-G; N-G	800	1200
L-L	1200	2000
L-N	900	1500

B. SPD Design:

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:

    a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.

        1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
        2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection:

The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

8. Safety Requirements:

The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable

modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

a. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

b. SPDs shall be factory sealed in order to prevent access to the inside of the unit. SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.2 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Main Service Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards)	120 kA	60 kA

C. SPD Type – SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.3 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.

2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
3. The panelboard shall be capable of re-energizing upon removal of the SPD.
4. The SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.

B. Side mount Mounting Applications Installation (SPD mounted external to electrical assembly):

1. Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

2.4 ENCLOSURES

A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:

1. NEMA 1 – Constructed of steel intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects.
2. NEMA 4 – Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure.
3. NEMA 4X – Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

3.2 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.3 WARRANTY

A. The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

END OF SECTION 264313

SECTION 265100 - INTERIOR BUILDING LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 DEFINITIONS

CCT:	Correlated color temperature
THD:	Total Harmonic Distortion
CRI:	Color-rendering index.
CU:	Coefficient of utilization.
RCR:	Room cavity ratio.
L70:	Minimum 70% maintained initial-rated lumens at average rated life for LEDs.
IESNA:	Illuminating Engineering Society of North America
LM-80:	IESNA approved method of measuring Lumen Depreciation of LED Light Sources
LED:	Light Emitting Diode
UL:	Underwriter Laboratories

1.3 SCOPE OF WORK

A. Extent of interior light fixture work is indicated by drawings and schedules.

B. Types of interior light fixtures in this Section include the following:

Light-emitting Diode

1.4 QUALITY ASSURANCE

A. Comply with the requirements of the NEC, as applicable to installation and construction of interior building light fixtures.

B. Provide interior light fixtures which are UL-Listed and labeled.

C. Provide LED drivers which comply with NEMA SSL-1, "Electronic Drivers for LED Devices, Arrays, or Systems", and SSL-3, "High Power White LED Binning for General Illumination".

PART 2 - PRODUCTS

2.1 INTERIOR LIGHT FIXTURES

A. Provide light fixtures of sizes, types, and ratings indicated; complete with, but not limited to, housings, reflectors, LED module, LED drivers and wiring. Provide fixture trims as required for proper installation into the type ceiling in which installed.

2.2 LED LIGHT FIXTURES

A. LED fixtures shall be in compliance with UL.

B. Interior Area LED Fixtures:

1. Kelvin temperature of interior fixtures as indicated on drawings.
2. Minimum of 75 plus lumens per watt.
3. CRI 80 or greater.
4. 5-year warranty minimum with L70 of 50,000 hours or greater.
5. Modular design for field replacement of parts.
6. Tool less access to driver and LED modules.
7. Cannot have LED pixilation (or commonly called bug eye effect).
8. UL certified up to 90F degrees operating temperature.

C. Manufactured by one of the following:

1. Signify.
2. Cree, Inc.
3. Philips LumiLED.
4. Osram Opto Semiconductors.
5. Cooper Industries.
6. Lusio Lighting.
7. Sony.
8. Citizens Electronics

2.3 RECESS- AND FLUSH-MOUNTED FIXTURES

A. Provide light fixture types which can be relamped from the bottom. Access to driver shall be from the bottom. Trim for the exposed surface of flush-mounted fixtures shall be as required for the ceiling construction in which it is installed.

2.4 SUSPENDED FIXTURES

A. Provide hangers capable of supporting twice the weight of the fixture supported by the hanger. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated

steel with a swivel-ball tapped for the conduit size required. Hangers shall be shock-absorbing type where indicated. Hangers shall allow fixtures to swing within an angle of 20 degrees. Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end, unless indicated otherwise. Rods shall be a minimum 1/4" diameter.

2.5 EXIT LIGHTS

A. Exit lights shall be in conformance with UL and NFPA. Exit lights shall be self-powered type where indicated.

B. Self-Powered LED-Type Exit lights (Battery Backup): Provide with automatic power failure device, test switch, pilot light and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than 5 years. LED exit lights shall have emergency run time of 1.5 hours (90 minutes) minimum.

2.6 EMERGENCY LIGHTING EQUIPMENT

A. Equipment shall be in conformance with UL and NFPA. Provide lamps in wattage indicated.

B. Emergency Lighting Unit: Provide as indicated. Emergency lighting units shall be rated for 12 volts, except units having no remote-mounted lamps and having no more than two unit-mounted lamps may be rated 6 volts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install interior light fixtures at locations and heights as indicated in accordance with fixture manufacturer’s published instructions, applicable requirements of the NEC, NECA “Standard of Installation,” NEMA standards, and with recognized industry practices to ensure that light fixtures fulfill requirements.

B. Coordinate with all other work on this Contract as appropriate to properly interface installation of interior light fixtures.

C. Fasten fixtures securely to building structural members, and check to ensure that solid pendant fixtures are plumb. Recessed fixtures shall be supported with individual annealed, light zinc-coated finish, 12-gauge wire from all four corners tied to building structural members. Securing safety wires to bridging is not acceptable. The supporting wires shall be distinguishable by color or tagging.

D. Clean interior light fixtures of dirt and debris (including lenses) upon completion of installation.

E. Protect installed fixtures from damage during entire construction period.

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation of interior light fixtures and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

B. At the time of Substantial Completion, replace lamps in interior light fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Engineer.

3.3 GROUNDING

A. Provide tight equipment grounding connections for each interior light fixture installation.

END OF SECTION 265100