PROJECT MANUAL

HVAC System Replacement
Newport News Public Schools
Booker T. Washington Middle School
Newport News, Virginia

IFB# 010-0-2025/SNB

THOMPSON
Consulting Engineers
Mechanical and Electrical Engineering
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NEWPORT NEWS PUBLIC SCHOOLS

MJT Project No. 21-156

February 11, 2025

Bid Set

SECTION 000002 - PROJECT DIRECTORY

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END OF SECTION 000002

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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.

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 19, 2026. 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 16, 2026. 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.
- The intent is for work to be completed during the summer of 2025 and summer of 2026. 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 indoor and outdoor Air Handling Units and Energy Recovery Units.
2. Replace Kitchen Makeup Air Unit and exhaust fan.
3. Replace chilled water pumps and convert to a variable primary system arrangement.
4. Replace primary and secondary hot water pumps and piping.
5. Replace existing boilers with condensing boilers and convert the hot water system from temperatures of 180°F/160°F to 140°F/110°F.

6. Replace hot water piping as required to accommodate increased flows due to lowered system temperatures.
7. Replace hot water piping Victaulic connections, where evidence of leaking is found, and replaced with welded spool pieces.
8. Replace variable air volume boxes and shutoff boxes with series fan powered variable air volume boxes with hot water coils.
9. Replace all units with hot water coils, including but not limited to cabinet unit heaters, unit heaters, duct heating coils, fan coil units, and fly fan.
10. Existing split systems will be replaced in kind as noted on the drawings.
11. Replace exhaust fans as identified on the drawings.
12. The installation of Bipolar ionization units in all air handling units.
13. Removal of domestic hot water storage tank.
14. Installation of tankless rack mounted gas fired water heaters for domestic hot water.
15. 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.
16. Provide Commissioning for all new mechanical units and controls.
17. All required electrical work to support the mechanical scope.
18. Removal and reinstallation of ceiling grid as required to support the mechanical and electrical scope.
19. 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.

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 indoor and outdoor Air Handling Units and Energy Recovery Units.
2. Replace Kitchen Makeup Air Unit and exhaust fan.
3. Replace chilled water pumps and convert to a variable primary system arrangement.
4. Replace primary and secondary hot water pumps and piping.
5. Replace existing boilers with condensing boilers and convert the hot water system from temperatures of 180°F/160°F to 140°F/110°F.
6. Replace hot water piping as required to accommodate increased flows due to lowered system temperatures.
7. Replace hot water piping Victaulic connections, where evidence of leaking is found, with welded in spool pieces.
8. Replace variable air volume boxes and shutoff boxes with series fan powered variable air volume boxes with hot water coils.
9. Replace all units with hot water coils, including but not limited to cabinet unit heaters, unit heaters, duct heating coils, fan coil units, and fly fan.
10. Existing split systems will be replaced in kind as noted on the drawings.
11. Replace exhaust fans as identified on the drawings.
12. The installation of Bipolar ionization units in all air handling units.
13. Removal of domestic hot water storage tank.
14. Installation of tankless rack mounted gas fired water heaters for domestic hot water.
15. 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.
16. Provide Commissioning for all new mechanical units and controls.
17. All required electrical work to support the mechanical scope.

18. Removal and reinstallation of ceiling grid as required to support the mechanical and electrical scope.
19. 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 2025 and Summer 2026.

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 if 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

BOOKER T. WASHINGTON 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, nondissipating.

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

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 Architect. Remove and replace concrete that cannot be repaired and patched to Architect'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 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Grout.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication of structural-steel components.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Mill test reports for structural steel, including chemical and physical properties.

D. Source quality-control reports.

E. Field quality-control and special inspection reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172).

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 360.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M.

B. Channels, Angles Shapes: ASTM A 36/A 36M.

C. Plate and Bar: ASTM A 36/A 36M.

D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B, structural tubing.

E. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.

F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.

2.3 PRIMER

A. Primer: SSPC-Paint 25, Type I, zinc oxide, alkyd, linseed oil primer.

B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.4 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

B. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.
6. Surfaces enclosed in interior construction.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

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

3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Baseplates Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

3.3 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1Mfor tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M.

END OF SECTION 051200

SECTION 055000 - METAL FABRICATIONS

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. This Section includes the following:

1. Loose steel masonry lintels.

1.3 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
2. Provide templates for anchors and bolts specified for installation under other Sections.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.6 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: ASTM A 1003/A, Structural Grade, Type H, metallic coated, of grade and costing wight as follows:

1. Grade: As required by structural performance.
2. Coating: G90 or equivalent.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers. HVAC System Replacement Richneck Elementary School, Newport News, VA.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.

D. Anchor Bolts: ASTM F 1554, Grade 36.

1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.

E. Eyebolts: ASTM A 489.

F. Machine Screws: ASME B18.6.3 .

G. Lag Bolts: ASME B18.2.1 .

H. Wood Screws: Flat head, ASME B18.6.1.

I. Plain Washers: Round, ASME B18.22.1 .

J. Lock Washers: Helical, spring type, ASME B18.21.1 .

K. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations: Alloy Group 1 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594 .

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

1. Use primer with a VOC content of 420 g/L (3.5 lb./gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat. HVAC System Replacement Richneck Elementary School, Newport News, VA.

1. Use primer with a VOC content of 420 g/L (3.5 lb./gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-

in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi , unless otherwise indicated.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. HVAC System Replacement Richneck Elementary School, Newport News, VA.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise

indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Furnish inserts if units are installed after concrete is placed.

C. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 LOOSE STEEL LINTELS AND BEAMS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.

B. Size loose lintels and beams to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches, unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls or outside.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.9 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123/A 123M, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 ADJUSTING AND CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Base wood blocking for rooftop equipment supports and roof curbs.
2. Wood blocking cants, and nailers.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.

C. Exposed Framing: Framing not concealed by other construction.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details. Wood treatment data as follows including chemical treatment manufacturer's instructions for handling, storing, installation, and finishing of treated material:

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
3. Warranty of chemical treatment manufacturer for each type of treatment.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent for more than 2-inch nominal thickness or less; unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat. items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2.3 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any of the following species:

1. Mixed southern pine or southern pine; SPIB.
2. Spruce-pine-fir; NLGA.
3. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

C. Concealed Boards: 15 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
2. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
3. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.4 FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Except as otherwise noted, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of AISI Type 304 stainless steel. All fasteners used shall be approved by manufacturer of treated wood prior to submitting to Architect for approval. Approval of manufacturer of treated wood shall be included in submittal of fasteners.

C. Screws for attaching roof blocking to roof blocking shall be Type 304 stainless steel and approved by the treated wood supplier. If not approved, provide screws as approved by treated wood manufacturer’s recommendations

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Wood Screws: ASME B18.6.1.

F. Lag Bolts: ASME B18.2.1.

G. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and where indicated, flat washers.

H. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch. Provide where material adjacencies and joints require a separator material: at all joints adjacencies with dis-similar materials, corners, install to act as a separator changes in direction or other applications to bridge gaps in exterior envelope.

I. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

J. Felts: Water and Ice Protection for separation of treated wood blocking from steel decking, where occurring. Provide felts or other approved separation sheet to separate other metal materials from exterior preservative treated lumber. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

2.5 PRESERVATIVE WOOD TREATMENT BY PRESSURE PROCESS

A. General: Where lumber or plywood is indicated as preservative- treated wood or is specified herein to be treated, comply with applicable requirements of AWPA Standards C2 (Lumber) and C9 (Plywood). Mark each treated item with the AWPB or SPIB Quality Mark Requirements.

B. Pressure-treat above-ground items with water-borne preservatives in accordance with referenced standards. For interior uses, after treatment, kiln-dry lumber and plywood to a maximum moisture content, respectively, of 19 percent and 15 percent. Treat indicated items and the following:

1. Wood nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

C. Pressure-treat wood members in contact with the ground or fresh water with water-borne preservatives in accordance with referenced standards.

D. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces to comply with AWPA M4. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

E. Warranty: Provide manufacturer’s standard warranty but not less than twenty (20) years.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction. Comply with AF & PA's "Details for Conventional Wood Frame Construction" unless otherwise indicated.

C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

D. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

F. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
2. ICC-ES evaluation report for fastener.
3. exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILERS

A. Install wood ground nailers, blocking, and sleepers where shown and where required for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.

B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated

C. Install permanent grounds of dressed, preservative treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

D. The thickness of blocking used in conjunction with the roofing system shall be as required to finish flush with the top of the roof insulation.

E. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

F. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet enough that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 075200 - PATCHING & REPAIR OF MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions of the Contract and of the Contract Documents apply to this Section.

1.2 SCOPE

A. This Section shall apply to roofing work at existing low-slope roofing of the Building. Patching and repairs are required in conjunction with removal of existing HVAC system components and/or placement of new HVAC system components, equipment, structural supports, curbs, utility distribution and related accessories. Existing low-slope roof at all areas of the building was installed in 1998 and is not under warranty. It is the intent under this contract for all patching materials to be compatible with existing modified bituminous roof membrane. It is also the intent to install new roof curbs, utility penetration housing(s), equipment and appurtenances. Interior of the building shall be kept watertight at the end of each day's work under this Contract.

This Section includes the following:

1. Roof membrane application:
    a. 2-ply Modified Bitumen roof, cold adhesive applied for slope equal or less than 1/4-inch/foot.
        1) NRCA #MBS-2-I-L-M (SBS)
2. Roof flashing application.
3. Incorporation of sheet metal flashing components and roofing accessories into the roof system.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 6 Section "Rough Carpentry" for sheathing, composite insulated sheathing, wood nailers, curbs, and wood cants.

1.3 REFERENCE STANDARDS

A. References in these specifications to standards, test methods, codes etc., are implied to mean the latest edition of each such standard adopted. The following is an abbreviated list of associations, institutions, and societies which may be used as references throughout these specifications.

1. ASTM: American Society for Testing and Materials
2. FM: Factory Mutual Engineering and Research
3. NRCA: National Roofing Contractors Association

4. OSHA: Occupational Safety and Health Administrations
5. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
6. UL: Underwriters Laboratories

1.4 DESCRIPTION OF WORK

A. The basic work descriptions (components, layering and attachment methods) required in this specification are referenced below. See also Parts 2 and 3 for specific products, preparation, application and details.

1. Project Type: Roof Patching and repairs
2. Roof Deck: Metal, above Two-Story Wing, Gypsum above the One-Story Wing.
3. Insulation: Minimum 2 layers of Polyisocyanurate: Mechanically attach first layer of insulation; secure subsequent layers of insulation and cover board with cold-applied adhesive in a thickness to match adjacent top of membrane.
4. Tapered Insulation: As required to provide positive drainage.

5. Cover Board: ASTM C 1177/C 1177M, glass-mat, 100% inorganic, water-resistant gypsum substrate, 5/8-inch (16 mm) thick.

    a. Georgia-Pacific: DensDeck™ Glass Mat-faced Gypsum Roof Board (and as branded by others)
    b. CertainTeed Corp.: GlasRoc™ Roof Board
    c. Rockwool: TOPROCK™ DD Plus (2 inches thick, may be used as upper layer of insulation in lieu of conventional 1/2-inch or 5/8-inch thickness coverboard).

6. Insulation - Acoustic Steel for Deck: Sound absorbing strip of glass or mineral fiber for depth of deck, in Division 5 Section “Steel Deck.”
7. MB Roof System (Primary): NRCA #MBS-2-I-L-M.

8. Existing Roof System Manufacturer:

    a. Manufacturer to be verified by NNPS.
    b. Only installers certified by this manufacturer will be allowed to bid on this project and perform roofing-related work under this Contract.
    c. Contractor shall submit evidence that that the roofing installer is authorized by the roofing manufacturer to perform work on its warranted roof system.
    d. Contractor shall submit the roofing system manufacturer’s letter of final inspection attesting to the Owner that the existing roof warranty remains in force and full effect, including all new work performed under this Contract.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

1.6 SUBMITTALS

A. Submit concurrently with Division 7 Section “Sheet Metal Flashing and Trim” for roofing system components included under total system warranty.

B. Product Data, including manufacturer's technical product data, installation instructions, and recommendations for each type of roofing product required. Include data substantiating that materials comply with requirements.

C. Samples of the following:

1. Roofing membrane base sheet.
2. Membrane granular-surfaced cap sheet.
3. Aluminum-foil surfaced flashing sheet.
4. Liquid-applied roofing membrane for low-slope (positive drainage) applications.
5. Roof insulation.
6. Six insulation fasteners of each type, length, and finish.

D. Provide evidence and description of manufacturer's quality control/quality assurance program for the primary roofing products supplied. The quality assurance program description shall include all methods of testing for physical and mechanical property values. Provide confirmation of manufacturer's certificate of analysis for reporting the tested values of the actual material being supplied for the project prior to issuance of the specified guarantee.

E. Descriptive list of the materials proposed for use.

F. Evidence of Underwriters' Laboratories Class A acceptance of the roofing system. No other testing agency approvals will be accepted.

G. Letter from the primary roofing manufacturer that the repair made will meet the requirement for continued warranty.

H. Complete list of material physical and mechanical properties for each sheet including: weights and thicknesses; low temperature flexibility; breaking load; ultimate elongation; dimensional stability; compound stability; granule embedment and resistance to thermal shock (foil faced products).

I. Letter from the primary roofing manufacturer confirming that the installer is an acceptable Contractor authorized to install the proposed system and was an acceptable authorized contractor at date of bid.

J. Submittals Prior to Project Close-Out:

1. Provide a Certificate of Analysis from the testing laboratory of the primary roofing materials manufacturer, confirming the physical and mechanical properties of the roofing

membrane components. Testing shall be performed in accordance with the parameters published in ASTM D 5147 and will indicate Quality Assurance/Quality Control data as required to meet the specified properties. A separate Certificate of Analysis is required for each production run of material and shall indicate the following information:

a. Material type
b. Lot number
c. Production date

d. Dimensions and Mass (indicate the lowest values recorded during the production run);

1) Roll length
2) Roll width
3) Selvage width
4) Total thickness
5) Thickness at selvage
6) Weight

e. Physical and Mechanical Properties:

1) Low temperature flexibility
2) Breaking load
3) Ultimate elongation
4) Dimensional stability
5) Compound stability
6) Granule embedment
7) Resistance to thermal shock (foil faced products)

1.7 QUALITY ASSURANCE

A. Acceptable Products: Provide primary roofing products, including each type of sheet, all manufactured in the United States, supplied by a single manufacturer which has been successfully producing the specified types of primary products for not less than ten (10) years. Provide secondary or accessory products which are acceptable to the manufacturer of the primary roofing products.

B. Product Quality Assurance Program: Provide primary roofing materials manufactured under a quality control/quality assurance program. A certificate of analysis for reporting/confirming the tested values of the actual material being supplied for the project will be required prior to project close-out.

C. Agency Approvals: The proposed roof system shall conform to the following requirements. No other testing agency approvals will be accepted.

1. Underwriters Laboratories Class A acceptance of the proposed roofing system .

D. Acceptable Contractor: Have a minimum of five (5) years' experience in successfully installing the proposed roofing materials and be certified in writing by the roofing materials manufacturer to install the primary roofing products.

E. Project Acceptance: Submit a completed manufacturer's application for roof guarantee form along with shop drawings of the roofs showing all dimensions, penetrations, and details. The form shall contain all the technical information applicable to the project including deck types, roof slopes, base sheet and/or insulation assemblies (with method of attachment, and fastener type), and manufacturer's membrane assembly proposed for installation. The form shall also contain accurate and complete information requested including proper names, addresses, zip codes and telephone numbers. The project must receive approval, through this process, prior to shipment of materials to the project site.

1. The Manufacturer shall provide on-the-job inspections at a frequency of every other week and provide technical assistance, and application guidance as necessary.

F. Manufacturer Requirements: The roofing materials manufacturer shall provide direct trained company personnel to attend necessary job meetings, perform periodic inspections as necessary, and conduct a final inspection upon successful completion of the project.

G. Recommended Maintenance: In addition to the guarantee, furnish to the Owner the manufacturer's printed recommendations of proper maintenance of the specified roof system including inspection frequencies, penetration addition policies, temporary repairs, and leak call procedures.

1.8 PRODUCT DELIVERY STORAGE AND HANDLING

A. Delivery: Deliver materials in the manufacturer's original sealed and labeled containers and in quantities required to allow continuity of application.

B. Storage: Store materials out of direct exposure to the elements. Store roll goods on a clean, flat and dry surface. All material stored on the roof overnight shall be stored on pallets. Rolls of roofing must be stored on ends. Store materials on the roof in a manner so as to preclude overloading of deck and building structure. Store materials such as solvents, adhesives and asphalt cutback products away from open flames, sparks or excessive heat. Cover all material using a breathable cover such as a canvas. Polyethylene or other non-breathable plastic coverings are not acceptable.

C. Handling: Handle all materials in such a manner as to preclude damage and contamination with moisture or foreign matter. Handle rolled goods to prevent damage to edges or ends.

D. Damaged Material: Any materials that are found to be damaged or stored in any manner other than stated above will be automatically rejected, removed and replaced at the Contractor's expense.

1.9 PROJECT/SITE CONDITIONS

A. Requirements Prior to Job Start

1. Preliminary Roofing Conference: As soon as possible after award of modified bitumen roofing work, meet with Installer (Roofer), installers of substrate construction (decks) and other work adjoining roof system including penetrating work and rooftop units, Architect, Owner, and representatives of other entities directly concerned with performance of roofing system including (as applicable) Owner's insurers and test agencies. Provide a minimum of 72 hours advanced notice to participants prior to convening pre-roofing conference.
2. Review requirements for tear-off of existing membrane roofing and phasing requirements of project.
3. Review requirements of Contract Documents, submittals, status of coordinating work, availability of materials, and installation facilities and establish preliminary installation schedule. Review requirements for inspections, testing, certifications, forecasted weather conditions, governing regulations, insurance requirements, and proposed installation procedures.
4. Discuss roofing system protection requirements for construction period extending beyond roofing installation.
5. Record discussion, including agreement or disagreement on matters of significance; furnish copy of recorded discussions to each participant within 7 days following the meeting. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference.
6. Notification: Give a minimum of five (5) days' notice to the Owner and manufacturer prior to commencing any work and notify both parties on a daily basis of any change in work schedule.
7. Safety: Familiarize every member of the application crew with all fire and safety regulations recommended by OSHA, NRCA and other industry or local governmental groups.

B. Environmental Requirements

1. Precipitation: Do not apply roofing materials during precipitation or in the event there is a probability of precipitation during application. Take adequate precautions to ensure that materials, applied roofing, and building interiors are protected from possible moisture damage or contamination.

C. Protection Requirements

1. Membrane Protection: Provide protection against staining and mechanical damage for newly applied roofing and adjacent surfaces throughout this project.
2. Limited Access: Prevent access by the public to materials, tools and equipment during the course of the project.
3. Debris Removal: Remove all debris daily from the project site and take to a legal dumping area authorized to receive such materials.
4. Site Condition: Complete, to the owner's satisfaction, all job site clean-up including building interior, exterior and landscaping where affected by the construction.

1.10 GUARANTEE/WARRANTY

A. Contractor's guarantees-Roofing Installer shall guarantee materials and workmanship of the finished installation to the full extent as that of the manufacturer's guarantee as outlined in this "Guarantee/Warranty" article.

1. Installer warranty shall be two (2) years from date of Final Acceptance.

a. Warranty shall be signed by the installer and the General Contractor.

PART 2 - PRODUCTS

2.1 ROOFING SYSTEM ASSEMBLY

A. Existing Roofing Membrane Assembly: A roof membrane assembly consisting of two (2) plies of a prefabricated, polyester-reinforced, homogeneous Styrene-Butadiene-Styrene (SBS) copolymer modified asphalt membrane secured to a prepared substrate. The modified bitumen base ply shall be fully adhered to the prepared substrate as specified herein, and shall possess waterproofing capability such that a phased roof application with only the modified bitumen base ply in place can be achieved for prolonged periods of time without detriment to the watertight integrity of the entire roof system, but shall not exceed the manufacturer's recommendations or a maximum of ninety (90) days extra. Provide roof system components meeting the following physical and mechanical requirements:

B. Styrene-Butadiene-Styrene (SBS) Modified Bitumen Roof System, Cold-Applied:

1. Modified Bitumen Base Ply: ASTM D6164/D6164M, Type II, Grade S, SBS-modified asphalt sheet, reinforced with polyester fabric, or ASTM D6162/D6162M, Type III, Grade S, hybrid polyester/fiberglass scrim/mat-reinforced; smooth surfaced; suitable for application method specified. Minimum 114 mil thickness.
2. Modified Bitumen Cap Sheet: ASTM D6164/D6164M, Type I, Grade G, SBS-modified asphalt sheet reinforced with polyester fabric, or ASTM D6162/D6162M, Type I, Grade G, SBS-modified asphalt sheet, hybrid polyester/fiberglass scrim/mat-reinforced; white ceramic-coated granular surfaced; suitable for application method specified. Minimum 130 mil thickness.
3. Stripping Ply: (Same as roof system base ply unless noted).
4. Flashing Membrane Assembly: ASTM D 6298, aluminum-foil-faced SBS-modified asphalt sheet (reinforced with fiberglass scrim/mat), equal to "Veral" Aluminum; suitable for application method specified. Flashings are to be installed in cold adhesive. No torching of base flashings is allowed.
5. Reinforcing Ply: Same as roof system base ply.

2.2 AUXILIARY ROOFING MEMBRANE MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.

B. Cold-Applied Adhesive: Roofing system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with roofing membrane and base flashings.

1. Adhesive for Roof Membrane: A cold-applied solvent based asphaltic adhesive meeting ASTM 4479 Type II. Typical coverage rate ranges from 1.5-2.5 gallons per square.
2. Adhesive for Aluminum Faced Base Flashing Membrane: A single component cold-applied solvent free flashing adhesive. Typical coverage rate ranges from 2.0-2.5 gallons per square.

C. Roofing Cement: Provide ASTM D 4586 asphalt roofing cement or roofing system manufacturer's modified asphalt roofing cement, asbestos free, of consistency required by roofing system manufacturer for application.

D. Mastic Sealant: Polyisobutylene, plain or modified bitumen; non-hardening, non-migrating, non-skinning, and nondrying.

E. Metal Flashing Sheet: Refer to Division 07 Section "Sheet Metal, Flashing and Trim."

F. Roofing Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing No. 8 sieve and 98 percent of mass retained on No. 40 sieve, color to match roofing membrane.

G. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

2.3 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.

1. Refer to Division 6 Section "Rough Carpentry" for composite nail base insulated sheathing for roof-side or parapet applications indicated.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.

2.4 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing membrane components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.

1. Metal Decks: Provide insulation mechanical fasteners and metal plates for metal decks that have been factory coated for corrosion resistance, and when subjected to 30 Kesternich cycles, must show less than 10 percent red rust, conforming to Factory Mutual 4470. Acceptable insulation fastener types for metal decks are listed below:

    a. Dekfast #12 + Dekfast Steel Hexagonal Plates, by Construction Fasteners, Inc.
    b. #12 Standard Roofing Fastener by Olympic Fasteners.

C. Insulation Adhesive: Provide the following.

1. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one-component or multi-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

D. Cover Board: ASTM C 1177/C 1177M, glass-mat, 100% inorganic, water-resistant gypsum substrate, 5/8-inch (16 mm) thick.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Georgia-Pacific Corporation; DensDeck™ Roof Board.
    b. National Gypsum Company; DEXcell™ FA Glass Mat Roof Board
    c. CertainTeed Corp.: GlasRoc™ Roof Board

E. Substrate Joint Tape: 6- or 8-inch- wide, coated, glass-fiber joint tape.

F. Insulation – Acoustic Steel for Deck: Sound absorbing strip of glass or mineral fiber for depth of deck, is specified in Division 5 Section “Steel Deck.”

2.5 ROOF ACCESSORIES

A. General: Provide the following roof accessories for managing roof penetrations and supporting rooftop-mounted mechanical equipment.

B. Metal Materials:

1. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coated.
2. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use, mill finished.
3. Stainless-Steel Shapes or Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 or Type 316, No. 2D finish.
4. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized to comply with ASTM A 123/A 123M, unless otherwise indicated.
5. Galvanized Steel Tube: ASTM A 500, round tube, hot-dip galvanized to comply with ASTM A 123/A 123M.
6. Galvanized Steel Pipe: ASTM A 53/A 53M.

C. Miscellaneous Materials:

1. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide non-removable fastener heads to exterior exposed fasteners.
2. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.
3. Elastomeric Sealant: ASTM C 920, polyurethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
4. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene, plasticized, and heavy bodied for hooked-type expansion joints with limited movement.

D. Prefabricated Roof Equipment Curbs: Provide metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1. Available Manufacturers:

    a. Colony Custom Curbs.
    b. Commodity Products Company, Inc.
    c. Conn-Fab Sales, Inc.
    d. Curbs Plus Inc.
    e. Custom Curb, Inc.
    f. LM Curbs.
    g. Loren Cook Company.
    h. Metallic Products Corporation.
    i. Pate Company (The).
    j. Roof Products & Systems Corporation.
    k. Roof Products, Inc.
    l. ThyCurb; Div. of Thybar Corporation.
    m. Uni-Curb, Inc.
    n. Vent Products Company, Inc.

2. Material: Galvanized steel sheet, 0.079 inch (2.0 mm) thick.
3. Liner: Same material as curb, of manufacturer's standard thickness and finish.
4. Factory install wood nailers at tops of curbs.
5. Factory insulate curbs with 1-1/2-inch- (38-mm-) thick, glass-fiber board insulation.
6. Curb height may be determined by adding thickness of roof insulation and minimum base flashing height recommended by roofing membrane manufacturer. Fabricate units to minimum height of 12 inches (300 mm), unless otherwise indicated.

E. Prefabricated Pipe Supports: Provide adjustable piping support products as manufactured by Roof Top Blox, 500 Distribution Parkway, Collierville, TN 38017, Model RTB-01, or equal product(s) as submitted to, and approved by, the Architect. Salient features include:

1. Materials: Support base shall be manufactured from 25 PSI plastic with a base not less than 9 inches by 9 inches by 1-inch thickness (nominal). Plastic may be from recycled products.

Supports shall be manufactured to permit secure insertion of an elevated, vertical, galvanized steel post or threaded rod. Post or rod shall be vertically-adjustable to permit alignment of supported element.

2. Pipe Clamps for Natural Gas Piping and Refrigerant Line Piping: Provide single post or rod shall fitted with a circular, galvanized steel split-ring clamp to support and secure the pipe. For multiple pipes, two posts or rods may be fitted with a horizontal support bar with pre-drilled holes allowing for securing of pipes with inverted, threaded, galvanized steel U-clamps and nuts. Provide clamping assemblies that do not crush pipe insulation.
3. Pipe Clamps for Condensate Piping: Provide single-pipe galvanized steel U-clamp assembly for secure attachment of PVC piping directly to the equipment support base.
4. Provide manufacturer's standard roof adhesive for attaching the support base to the roof membrane. In lieu of an adhesive product by the pipe support manufacturer, substitute an adhesive approved for use by the roof membrane manufacturer.

F. Pre-Fabricated Utility Penetration (Chase) Housing: Provide "Vault" products as manufactured by Roof Penetration Housings, LLC, P.O. Box 461024, San Antonio, TX 78246 (Ph 800-994-0945) or provide equal products by another manufacturer approved in advance by the Architect, based upon Medium" Vault Chase Housing," Model No. AWI/AW-201412.

1. Housing size: 21 ½ inches long by 14 ½ inches wide.
2. Housing height (above curb): 14 inches.
3. Curb height (without housing): 8 inches.
4. Material: Welded powder coated aluminum.
5. Seals: Provide manufacturer's pre-fabricated seals for power, controls and refrigerant lines as required at each location. Coordinate with mechanical and electrical requirements.
6. Location: As shown on the Contract Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide roof for limited removal of roof membrane and substrate in accordance with the drawings and requirements of Section 024119, "Selective Demolition." Coordinate removal of roofing membrane and substrate carefully with provision and layout of new rooftop-mounted mechanical equipment and associated electrical utilities. Identify all existing roof structural members below prior to locating and laying out roof penetrations.

B. General: Sweep or vacuum all surfaces, removing all loose aggregate and foreign substances prior to commencement of roofing. Coordinate disconnection removal reinstallation and reconnection of all roof top plumbing, mechanical, and electrical items that may have been connected or installed prior to roofing that requires roofing to be properly installed or flashed.

3.2 SUBSTRATE PREPARATION AND INSULATION INSTALLATION

A. Insulation: Comply with insulation manufacturer's instructions and recommendations for the handling, installation, and bonding or anchorage of insulation to substrate. Examine substrate before starting work. Surfaces to receive insulation shall be clean, smooth, and dry. Verify that

wood blocking has been installed at edges, walls, and other openings. Install insulation panels with end joints offset; edges of the panels shall be in moderate contact without forcing applied in strict accordance with the insulation manufacturer's requirements and the following instructions.

1. Acoustical Steel Deck Sound-Absorbing Insulation: Install manufacturer's standard pre-molded roll or strip of mineral fiber into topside of deck prior to installation of base layer and tapered layers of roofing insulation.

B. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

C. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 12 inches in each direction.

1. At sloping deck, provide two layers of 2 inch thickness polyisocyanurate. Install coverboard over this insulation. Crickets, cants, and tapered edge strips are also in addition to the polyisocyanurate insulation board thickness.
2. At level decks, provide polyisocyanurate insulation thickness indicated, in two layers unless noted otherwise. Install coverboard over this insulation. Crickets, cants, and tapered edge strips are also in addition to the polyisocyanurate insulation board thickness for the primary roof planes.

D. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten first layer of insulation over entire area of roofing at spacing as required by FM for Windstorm Resistance Classification I-90. Run long joints for insulation in continuous straight lines, perpendicular to roof slope with end joints staggered between rows.
2. Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place. Provide adhesive bead spacing as required for uplift requirements at roof field, perimeter and corner applications. Stagger joints of second layer a minimum of 12 inches each direction from joints of first layer.

E. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows, set in adhesive for full bond. Offset joints a minimum of 6 inches in each direction from joints of insulation below. Loosely butt cover boards together. Tape joints if required by roofing system manufacturer.

1. Cricket Areas: Construct crickets of tapered polyisocyanurate panels between the roof drains. Install each cricket directly over the surface of the top layer of insulation to facilitate prompt and complete removal of water to each roof drain.
2. Trim surface of insulation where necessary at roof drains so completed surface is flush with ring of drain.

3.3 ROOF MEMBRANE INSTALLATION

A. Prime all lap areas prior to installation for the base sheet.

B. Install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

1. Install roofing system MBS-2-I-L-M, according to roof assembly identification matrix and roof assembly layout illustrations in "The NRCA Roofing and Waterproofing Manual" and to requirements in this Section.

C. Coordinate installation of roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. At end of each day's work, provide tie-offs to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement, with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

D. Substrate-Joint Penetrations: Prevent adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

E. Aesthetic Considerations: The overall appearance of the finished roof application is a standard requirement for this project. The Contractor shall make necessary preparations, utilize recommended application techniques, apply the specified materials (i.e., granules, metallic powder, etc.), and exercise care in ensuring that the finished application is acceptable to the Owner.

F. The Manufacturer's Quality Control Representative shall visit the site every other week, and at conclusion of the project. Representative shall provide 24-hour notice to the Owner of all visits made to the site and shall submit to the Architect/Engineer, within 3 days following site visits, written reports of findings from their field visits. Failure to provide visits and reports shall be cause for withholding pay application for roofing materials and labor and shall be cause of removal of roofing contractor from project without further notice.

G. Priming: Prime metal flanges (all jacks, edge metal, lead drain flashings, etc.) and concrete and masonry surfaces with a uniform coating of asphalt primer ASTM D 41.

H. Adhesive Consistency: Cutting or alterations of adhesives, primer, and sealants will not be permitted.

I. Roofing Application: Apply all layers of roofing free of wrinkles, creases or fishmouths. Exert sufficient pressure on the roll during application to ensure prevention of air pockets. Lap seams in the base ply layer should not coincide with the lap seams of the finish ply layer. Heat-weld lap seams in accordance with membrane manufacturer's recommendations. The courses should be staggered to ensure this.

1. Apply all layers of roofing perpendicular to the slope of the deck.
2. Fully bond the base ply to the prepared substrate, having a minimum of three (3) inch side and end laps. Each sheet shall be applied directly in cold-applied adhesive.
3. Fully bond the finish ply to the base ply, having a minimum of three (3) inch side and end laps. Each sheet shall be applied directly in cold-applied adhesive.
4. Maximum sheet lengths and special fastening of the specified roof membrane system may be required at various slope increments where the roof deck slope exceeds one-half (1/2) inch per foot. The manufacturer shall provide acceptable sheet lengths and the required fastening schedule for all roofing sheet applications to applicable roof slopes.

J. Liquid-Applied Roofing and Flashing Application: At low slope areas and membrane penetration flashing applications install in accordance with manufacturer's instructions. Provide primer or SBS membrane base-ply to the secured top surface of the completed modified bitumen roofing system as required by fluid-applied roofing system for warranted application. The polyester-reinforced liquid-applied roof membrane will be installed to the top surface of the prepared substrate.

1. Flash standard base flashings: Install polyester-reinforced liquid-applied flashings in areas shown on the details. Bond the flashings directly to the surface of the modified bitumen roofing system completed cap sheet.
2. Flash with Polyester-Reinforced Liquid-Applied Flashings: Install the catalyzed flashing resin on the surface of the modified bitumen roofing system completed cap sheet and the vertical primed surface of the walls and penetrations. Place flashing resin on the back of the reinforcing fleece and install in place at the flashing. Coat the top layer of the fleece with an additional layer of flashing resin.
3. Install Polyester-Reinforced Liquid-Applied Roof Membrane: When the flashing has set up, install the polyester-reinforced liquid-applied roof membrane resin directly to the top surface of the prepared substrate. Imbed the fleece in the resin, and topcoat with another layer of resin in accordance with manufacturer's instructions.

K. Flashing Application: Use only cold applied adhesive. Flash curbs using the modified bitumen reinforcing sheet and the metal foil flashing membrane. The reinforcing sheet shall have minimum three (3) inch laps, extending a minimum of three (3) inches onto the base ply surface and on vertical wood or masonry substrate as indicated. After the finish ply has been applied to the top of the cant, prepare the surface area that is to receive flashing coverage by application of asphalt primer to foil surfaces; allowing primer to dry thoroughly. Adhesive apply the metal foil flashing into place using three-foot lengths (cut from the end of roll) and using the factory selvage edge for laps, extending a minimum of four (4) inches beyond the toe of the cant onto the prepared surface of the finished roof. Exert pressure on the flashing sheet during application to ensure complete contact with the wall/roof surfaces, preventing air pockets; this can be accomplished by using a damp sponge or shop rag. Check and seal all loose laps and edges. Nail the top edge of the flashing on nine (9) inch centers. (See manufacturer's schematic for visual interpretation).

1. Heat-Welded Seams: Do not apply adhesive within two inches of edges of cap sheets. Heat weld underside of the exposed edge seam to substrate sheet below using a hand-held hot-knife or other appropriate heated tool as recommended by the roofing manufacturer.

L. Water Cut-Off: At end of day's work, or when precipitation is imminent, construct water cut-off at all open edges. Cut-offs can be built using asphalt or plastic cement and roofing felts,

constructed to withstand protracted periods of service. Cut-offs must be completely removed prior to the resumption of roofing.

3.4 ROOF SYSTEM INTERFACE WITH RELATED COMPONENTS

A. The following is a list of verbal descriptions for correct installation of components integrated into the roof membrane assembly. In all cases, unless otherwise approved, incorporate flanged components into the system between the application of the base ply and the finish ply. The flange must be primed with a uniform coating of approved ASTM D 41 asphalt primer and allowed to dry thoroughly; all flanges must be set in approved mastic.

1. Metal flashings: Completely prime metal flanges and allow to dry prior to installation. After the base ply and continuous cleat (if applicable) have been installed, set the flange in mastic and stagger nail every three (3) inches on center. Strip-in the flange using the cap ply material, extending a minimum of four (4) inches beyond the edge of the flange.
2. Sealant: Caulk all exposed finish ply edges at all flashings, with a smooth continuous bead of approved sealant.

3.5 INSTALLATION OF ROOF ACCESSORIES

A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Install roof accessories to fit substrates and to result in watertight performance.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.

D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks. Level all equipment supports and rails as required for proper installation and operation of mechanical or electrical equipment placed thereupon.

E. Seal joints with elastomeric sealant as required by manufacturer of roof accessories. Apply sealants in strict accordance with manufacturer’s installation instructions.

3.6 FIELD QUALITY CONTROL AND INSPECTIONS

A. Site Condition: All areas around job site shall be free of debris, roofing materials, equipment and related items after completion of job.

B. Notification of Completion: Contractor shall notify manufacturer by means of manufacturer's printed Notification of Completion form of job completion in order to schedule a final inspection date.

C. Final Inspection:

1. Post-Installation Meeting: Hold a meeting at the completion of the project, attended by all parties that were present at the pre-job conference. A punch list of items required for completion shall be compiled by the Contractor and the manufacturer's representative. Complete, sign, and mail the punch list form to the manufacturer's headquarters.
2. Drain Verification: At final inspection of all work, verify that all drains, scuppers, etc., are functioning properly. Drains shall have adequate strainers.

D. Issuance of the Guarantee: Complete all post installation procedures and meet the manufacturer's final endorsement for issuance of the specified guarantee.

E. Within thirty (30) days of Substantial Completion roofing contractor shall perform an infrared survey to ascertain the presence of moisture in the roof system and submit copies to Contractor, Owner and Architect. Any finding of moisture shall be remedied and necessary repairs made in compliance with manufacturer’s warranty requirements.

F. Two-Year Inspection: Contact the manufacturer during the ninety (90) day period immediately preceding the two (2) year anniversary of the guarantee date to arrange for a mandatory two-year inspection. The inspection shall be attended by the Owner, Architect-Engineer, and Contractor and the manufacturer's representative. A two-year inspection punchlist shall be compiled by the manufacturer and submitted to the Contractor for his completion. Upon completion, sign and mail the punchlist form to the manufacturer's headquarters, verifying that all items are in accordance with the manufacturer's recommendations.

END OF SECTION 075200

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-0 and Division 1 Specification sections, apply to work of this section.

1.2 SCOPE

A. This Section includes the following:

1. Metal counter flashing and base flashing.
2. Miscellaneous sheet metal accessories.
3. Termination Bars

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 075216 “Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing”.
3. Section 076200 “Joint Sealants” for field-applied sheet metal flashing and trim sealants.
4. All materials specified in this section shall be provided by the roofing system manufacturer or by a manufacturer approved by the roofing system manufacturer for use in the roofing system.
5. All materials specified in this section installed in conjunction with the roofing shall form part of the System Warranty required by Division 7, 075216 “Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing”.

1.3 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

C. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

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

B. Product data, Flashing, Sheet Metal, and Accessories: Manufacturer's technical product data, installation instructions and general recommendations for each specified sheet material and fabricated product.

C. Samples of the following flashing, sheet metal, and accessory items:

1. 12-inch-long samples of factory-fabricated products exposed as finished work. Provide complete with specified factory finish.

D. Shop drawings showing layout, profiles, methods of joining and turning directions/angles and anchorages details, including major counter flashings. Identify material, thickness, weight and finish for each item and location. Provide layouts at 1/4-inch scale and details at 3-inch scale.

E. Samples for initial selection purposes in form of manufacturer's sample finishes showing full range of colors and textures available for those units with factory-applied color finishes.

F. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Sheet Metal Flashing: 12 inches long. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim: 12 inches long. Include fasteners and other exposed accessories. Accessories: Full-size Sample.

G. Qualification data for firms and persons specified in the “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of complete projects with project names and addresses, names and addresses of architects and owners and other information specified.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed sheet metal flashing and trim work similar in material design, and extent to that indicated for this project and with a record of successful in-service performance.

B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1. Copper Standard: Comply with CDA's "Copper in Architecture Handbook."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.7 COORDINATION

A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

1.8 PROJECT CONDITIONS

A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

PART 2 - PRODUCTS

2.1 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

2.2 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support and Curb Flashing (Flashing at top of curb which terminates roofing membrane):

1. Two-piece metal counter flashing assembly (counter-flashing with separate flashing receiver)
2. Material selection:

    a. Stainless Steel: 0.0188 inch thick.
    b. Galvanized Steel: 0.028 inch thick.
    c. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

3. Units of type, material, and profile required, both components of same metal, receiver formed to provide secure interlocking (snap-lock) of separate counterflashing piece, interlocking counterflashing occurring on exterior face with profile extending away from back side of assembly and returning to back side providing spring tension and pocket area for termination bar., compatible with other flashing components indicated, shop fabricated bent corners units and junctions (factory fabricated -mitered and -welded corners where premanufactured heavy gauge products are selected). Corners of flashing units shall not be field mitered and sealed with sealant. The profiles must turn the corners with no visible or exposed joints which permit the infiltration of moisture.

2.3 UNDERLAYMENT FLASHING MATERIALS

A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.

1. Source Limitations: Obtain underlayment from single source from single manufacturer.
2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners**,** protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.

2. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
3. Fasteners for Zinc-Coated (Galvanized) and Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

F. Termination bar:

1. Characteristics: 1 inch height minimum, fastener points shall be slots spaced at 8 inch maximum, 18 gauge minimum thickness, fabricated from stainless steel or aluminum alloy metal, continuous horizontal 1/4 inch sealant ledge (ledge lip), underside of main body (side facing substrate when installed) shall have multiple continuous horizontal ribs/projections (serrated) and the have the ability to compress (bite) material and mastic to achieve constant compression when fastened to material seeking to terminate.
2. Termination bars to be installed in longest continuous lengths possible to minimize joints in the run. Where joints occur, provide brake metal alignment clips to straddle the termination bar joint, clips to be 22 ga., 6 inches wide, same material as term bar, fastening holes to be horizontal slots allowing for expansion and contraction of adjoining term bars and aligned with holes of termination bar behind, profile to wrap the front and back sides and conform to the termination bar profile.

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

D. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, and securely anchored.
3. Verify that the self-adhered water-resistant barrier underlayment flashing has been installed over roof curb, as indicated in the drawings, to prevent water penetration.

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

3.2 INSTALLATION OF UNDERLAYMENT FLASHING

A. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in few pieces as possible.
5. Overlap side edges not less than 3-1/2 inches.
6. Roll laps and edges with roller.
7. Cover underlayment flashing within 14 days.

3.3 INSTALLATION, GENERAL

A. General: Except as otherwise indicated, comply with manufacturer's installation instructions and recommendations and with SMACNA "Architectural Sheet Metal Manual." Anchor units of work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.

B. Install exposed sheet metal work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-

resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surface, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.

1. Underlayment: Where stainless steel or aluminum is to be installed directly on wood substrates, install a slip sheet of red rosin paper and a course of polyethylene underlayment.
2. Bed flanges of work in thick coat of roofing cement where required for waterproof performance.

3.4 INSTALLATION OF MISCELLANEOUS FLASHING

A. Equipment Support and Roof Curb Flashing:

1. Coordinate installation of equipment support curb flashing with installation of roofing and equipment.
2. Where equipment manufacturer provides integral metal skirt flashing to comply with equipment warranty, coordinate installation of 2-piece metal counter flashing to be situated and installation compatible with the manufacturer and project requirements.

B. Termination Bar:

1. Allow 1/4” to 1/2” maximum spacing between bars, install runs so they are plumb and level. Fasten at 8” o.c. with fasteners made of same material as termination bar and at lengths required to reach anchoring and resist required forces.
2. Utilize alignment clips at run joints.
3. Apply lap sealant at top edge of bar and feather.

3.5 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Protection: Provide required protection of flashings and sheet metal work during construction to ensure that work will be without damage or deterioration other than natural weathering at time of Substantial Completion and Final Acceptance.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

D. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

E. Maintain sheet metal flashing and trim in clean condition during construction.

F. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Requirements:

1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, and in smoke barriers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approval according to FM Approval 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

        1) UL in its "Fire Resistance Directory."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.4 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

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. The extent of each form and type of joint sealer is indicated on drawings and by provisions of this section.

B. The applications for joint sealers as work of this section include but is not limited to the following:

1. Flashing joints.
2. All joints indicated to be caulked.
3. All joints not specifically indicated, but necessary to obtain complete weathertight construction.

C. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.

D. Related Sections:

1. Division 7 Section 076200 "Sheet Metal Flashing and Trim" for sealing joints sheet metal laps.

E. General Performance: Except as otherwise indicated, joint sealers are required to establish and maintain airtight and waterproof continuous seals on a permanent basis, within recognized limitations of wear and aging as indicated for each application. Failures of installed sealers to comply with this requirement will be recognized as failures of materials and workmanship.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

2. Submit not fewer than four pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product specifications, handling/installation/curing instructions, and performance tested data sheets for each elastomeric product required.

B. Sustainable Design Submittals

1. Product Data: For sealants and sealant primers used inside the weatherproofing system, including printed statement of VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low emitting materials.

C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view. Provide custom colors where required and herein specified.'

D. Certified Tests: With product data, submit certified test reports for elastomeric sealants on aged performances as specified, including hardness, stain resistance, adhesion, cohesion or tensile strength, elongation, low-temperature flexibility, compression set, modulus of elasticity, water absorption, and resistance (aging, weight loss, deterioration) to heat and exposures to ozone and ultraviolet.

1. Qualification Data: For qualified testing agency.

E. Samples: Submit actual samples of sealants for color approval. Submit 6 inch lengths of product in in cardboard backer.

F. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

G. Product Test Reports: Based on evaluation of comprehensive tests performed or witnessed by a qualified testing agency, indicating that sealants comply with requirements.

H. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

I. Field-Adhesion-Test Reports: For each sealant application tested.

J. Sample Warranties: For special warranties.

K. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested.

1. Joint-sealant location and designation.
2. Manufacturer and product name.
3. Type of substrate material
4. Proposed test.
5. Number of samples required.
6. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

L. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.

3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with stone or masonry substrates.
4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

        1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

5. Where joint widths have not been cleaned of all obstructing materials.

1.8 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. General Sealer Requirements:

1. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
2. Provide colors indicated or, if not otherwise indicated, as selected by Architect/Engineer. Color of sealant for joints in face brick or face brick adjacent to existing window frame shall be custom mixed to exactly match the color of the brick or existing aluminum window frame per Architect choice.
3. Where color is indicated to match adjacent surface, sealant color will be selected by Architect/Engineer from manufacturer’s standard colors. If no standard color is an acceptable match, sealant color shall be custom mixed to obtain acceptable color match at no additional cost to the Owner. Colors shall match adjacent surface color unless otherwise indicated or selected by Architect.
4. Sealant materials shall not contain mercury, lead, or asbestos.

B. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of serviced and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

C. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weather proofing system that comply with the following limits for VOC content when calculated according to 40 CPR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant primers for Nonporous Substrates: 250 g/L.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Colors of Exposed Joint Sealants: Shall be custom colors.

E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

2.2 SEALANTS

A. All interior joints, including saw joints in concrete floors where applied finish will be tile or terrazzo, expansion joints, and exterior wall control joints shall be caulked with two component urethane type, ASTM C 920, Type M, Grade NS, Class 50, for Use T unless otherwise noted. Color to match lighter of adjacent painted surfaces.

B. N/A this project: All joints in ceramic tile or quarry tile areas shall be caulked with single component mildew resistant silicone rubber type, ASTM C 920, type S, Grade NS, Class 50, for Use NT unless otherwise noted. Color shall match grout color.

1. All joints in ceramic tile and quarry tile in a horizontal plane subject to foot traffic shall be caulked with mildew resistant silicone rubber type, ASTM C 920, type M, Grade NS, Class 25, for Use T. Color shall match grout color.

C. Caulking Compound or Sealants:

1. Expansion joints, control joints, and exterior window and door frames shall be caulked with two component urethane type, ASTM C 920, Type M, Grade NS, Glass 50, for Use NT. Color to match color of brick where caulking occurs in brick masonry work and color of frames at exterior aluminum doors and windows.

D. Acoustical sealant shall be Hilti CP 506 Smoke and Acoustic Sealant; Grabber Acoustical Sealant GSC; STI Spec Seal Smoke N Sound Caulk; BOSS 824 Acoustical Sound Sealant or approved equal.

2.3 URETHANE JOINT SEALANTS

A. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, Use NT.

2.4 JOINT-SEALANT BACKING AND JOINT FILLERS

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cellular/Foam Joint Fillers and Sealant Backers for building expansion joint fillers and concrete expansion joint material (preformed joint filler, compressible filler, expansion joint material):

1. Expanded Polyethylene Joint Filler: Provide flexible, compressible, closed-cell, polyethylene of not less than 10 psi compression deflection (25%); except provide higher compression deflection strength as may be necessary to withstand installation forces and provide proper support for sealants; surface water absorption of not more than 0.1 pounds per square foot.
2. Bond Breaker Tape: Provide polyethylene tape or plastic tape as recommended by sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant. Provide self-adhesive tape where applicable.

C. Cylindrical Sealant Backings (Backer Rod): ASTM C 1330, Type C (closed-cell material with a surface skin), or as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

2.5 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated. Provide type of joint primer/sealant recommended by sealant manufacturer for joint surfaces to be primed or sealed in accordance with ASTM C 1087.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

2.6 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide sealants from one of the following:

1. Sonneborne, Inc.
2. Hilti, Inc.
3. Pecora Inc.
4. Sika Corporation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance. Installer must examine substrates, (joint surfaces) and conditions under which joint sealer work is to be performed, and installer must notify Contractor in writing of unsatisfactory conditions. Do not proceed with joint sealer work until unsatisfactory conditions have been corrected in a manner acceptable to Installer. Verify that masonry expansion and control joints have been raked and are clear of mortar.

1. Where two-part sealants are used, sealants shall be mixed on site from original containers.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Etch concrete and masonry joint surfaces as recommended by sealant manufacturer. Roughen vitreous and glazed joint surfaces as recommended by sealant manufacturer. Porous joint substrates include, but are not limited to:

a. Concrete.
b. Masonry.

c. Unglazed surfaces of ceramic tile.
d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include, but are not limited to the following:

a. Metal.
b. Glass.
c. Porcelain enamel.
d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements are shown or specified, except where manufacturer's technical representative directs otherwise and is approved by the Architect. Sealant shall be required in all control (CJ), fire control (FCJ), and expansion (EJ) joints regardless of whether the control joint, fire control joint, or expansion joint is concealed or not, i.e., full height of wall, above and below ceilings, concealed and not concealed.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross- sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
4. Install acoustical sealant in accordance with ASTM C 919.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
4. Provide flush joint profile at locations indicated on Drawings according to Figure 8B in ASTM C 1193.
5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings according to Figure 8C in ASTM C 1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Install liquid-applied sealant to depths as shown or, if not shown, as recommended by sealant manufacturer

H. Spillage: Do not allow sealants or compounds to overflow from confines of joints, or to spill onto adjoining work, or to migrate into voids of exposed finishes. Clean adjoining surfaces to eliminate evidence of spillage.

I. Caulk solidly around entire perimeter of openings using a nozzle of proper size to fit joints. Use sufficient pressure to fill all voids and joints solid.

J. Set sills and thresholds in a full bed of caulking compound.

K. Remove excess compound, after sill or threshold is set and point.

L. Finish all caulked joints with the proper tool and remove caulking compound from all adjacent surfaces. Exposed caulking shall have a smooth even finish and be free from wrinkles.

M. All caulked joints shall be watertight.

N. Caulk joint between metal door frames and masonry construction.

O. Follow manufacturer's direction for each type of joint.

P. Caulk around entire perimeter of all windows on both the exterior side and the interior side.

Q. Control joints in cavity wall CMU shall be caulked prior to application of dampproofing and sprayed urethane foam insulation.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

    a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
    b. Perform one test for each 1000 feet (300 m) of joint length thereafter or one test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

    a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

    a. Whether sealants filled joint cavities and are free of voids.
    b. Whether sealant dimensions and configurations comply with specified requirements.
    c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Advise Contractor of procedures required for cure and protection of joint sealers during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of Substantial Completion. Cure and protect sealants in a manner which will minimize increases in modulus of elasticity and other accelerated aging effects. Replace or restore sealants which are damaged or deteriorated during construction period.

END OF SECTION 079200

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.

B. Related Sections include the following:

1. Division 05 Section "Cold-Formed Metal Framing" for metal stud framing and furring that supports gypsum board.
2. Division 07 Section "Thermal Insulation" for insulation and vapor retarders installed in assemblies that incorporate gypsum board.
3. Division 09 painting Sections for primers applied to gypsum board surfaces.

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 Wallboard: ASTM C 1396/C 1396M; for use at all locations except where specified otherwise.

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

C. 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. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    b. At high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.

3. 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 220500 - PLUMBING

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 SERVICE CONNECTIONS

A. Make arrangements with local gas company for verification of existing gas meter capacity gas service and meter. Replace meter if required.

1.3 PERMITS

A. Contractor shall give all required notices and secure all necessary permits. Inspection certificates from local authorities having jurisdiction shall be delivered to the Engineer prior to final payment.

1.4 GENERAL REQUIREMENTS

A. Follow Plumbing Code for minimum requirements; where drawings or specifications are at variance with Code, follow whichever provides for maximum size or condition.

B. All pipe, fittings and fixtures that are connected to potable water systems must meet the current Water Drinking Act and where applicable, meet NSF Standard 61 and be so labeled and be so certified. All plumbing valves, devices, fixtures and fittings shall be lead free.

1.5 SUBMITTALS AND SHOP DRAWINGS

A. Submit manufacturer’s data on the following:

Valves
Tankless Gas-Fired Water Heaters
Recirculating Pumps
Thermometers
Thermal Expansion Tanks
Mixing Valve
Neutralization Trap

B. Submit shop drawings on the following:

Gas-fired Tankless Water Heaters

C. Submit a schedule of all pipe materials to be used for each type of service.

1.6 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. During the guarantee period, the Contractor shall repair or replace defective material and workmanship and place same in working order to the satisfaction of the Engineer at no additional expense to the Owner.

C. Contractor shall service the systems for 12 months from date of Substantial Completion. Such service shall include all emergency services and adjustments, except cleaning of filters and screens.

PART 2 - PRODUCTS

2.1 WATER PIPING

A. Water piping shall be copper tubing Type L, hard-tempered above ground. Piping shall be assembled with wrought-copper fittings using 95-5 solder above ground.

2.2 GAS PIPING

A. Gas piping above ground 1/2" through 2" shall be Schedule 40 black steel screw fabricated using malleable-iron fittings and piping 2-1/2” and over shall be fabricated by welding using schedule 40 steel welded fittings.

B. Provide shut-off valves on gas mains, risers and branches where indicated and at connection to all gas-burning equipment.

2.3 GAS REGULATOR

A. Provide 1” gas pressure regulator where indicated. The regulator body shall be made of cast iron with a die cast aluminum alloy, corrosion resistant diaphragm case. The regulator shall be equipped with an internal relief, a 3/8” orifice, and green 6” to 14” W.C. spring. The regulator

shall be vented to outdoors where indicated. Gas regulators with equivalent characteristics by Honeywell or Maxitrol are acceptable.

2.4 VALVES

A. Provide valves on piping as indicated and as required to isolate equipment and to give complete control of water in risers and branch lines. Valves shall be ball, unless otherwise indicated. All valves shall be lead-free.

B. No cast-iron valves shall be used on domestic hot water piping. Valves shall be bronze or brass body valves only.

C. Valves on copper water piping, up to and including 2", shall be bronze or brass. Gate Valves 2-1/2" and larger shall be cast-iron body, bronze-mounted with companion flanges. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Catalog numbers indicated are NIBCO. Valves with equivalent characteristics by APOLLO or MILWAUKEE are acceptable.

Type	Size	Catalog Number
Ball	2-1/2" - 3"	S-FP-600A-LF
Ball	2" and smaller	S-585-80-LF

D. All gas valves 3" and smaller shall be bronze body, threaded with bronze trim ball valves. Gas valves shall be UL-Listed. Valves shall be as manufactured by NIBCO model T-585-70-UL or approved equal.

2.5 MIXING VALVES

A. Provide complete mixing valves as indicated and scheduled on contract documents. Mixing valves shall meet ASSE standards for intended use as listed below. LEONARD numbers indicated, equal by POWERS or BRADLEY.

1. ASSE 1017: Hot Water Distribution Systems

2.6 CONDENSING TANKLESS GAS FIRED WATER HEATERS

A. The Tankless Commercial Rack System NAVIEN or approved equals by RINNAI or BOSCH .

1. Tankless gas fired rack system shall be field assembled pre-plumbed with manifolds include condensing tankless water heaters.
2. The commercial rack system shall include copper water supply lines, flexible stainless steel water lines to the heaters, schedule 40 gas supply pipe CSST flexible gas lines to the heaters, and isolation valves with 150 psi pressure relief valves for each heater.
3. The rack shall be assembled as a floor mount design per plans.
4. The fully modulating, on-demand, condensing gas fired tankless water heaters shall have maximum input rating of 199,000 Btu/h. The heater shall have male NPT water and gas

connections. The inlet gas supply pressures shall be 3.5 in. WC (min.) up to 10.5 in. WC (max.).

5. The indoor heaters shall incorporate an integrated temperature controller that will provide diagnostic information, fault history, and heater set temperature as well as multi-unit programming.
6. The heaters will have an onboard circulator and buffer tank that can be set up for internal or external recirculation as shown on the plans to eliminate "cold water sandwich" and provide programable efficient domestic hot water recirculation to the building. The heaters will incorporate a factory installed power cord.
7. The heaters shall be vented with 2" diameter schedule 40 PVC, CPVC, and installed per the manufacture's venting instructions terminating horizontally. Proper sizing is provided in the heater's installation manual.
8. The water heaters shall use commercial grade stainless steel primary and secondary heat exchangers.
9. The heaters shall be controlled by an onboard solid-state printed circuit board which uses the following factory installed components: thermistors to monitor water temperature and exhaust temperature; a flow sensor to measure flow rate; a flame sensor to monitor combustion; an air-fuel ratio rod to measure and adjust air inputs in order to maintain optimal combustion efficiency.
10. The heaters shall utilize a negative pressure venturi style gas valve to maintain accurate fuel/air mixture.
11. The heater also consists of inline fusing and surge protectors for electrical surge protection, an electronic spark igniter, stainless steel burners, hi-limit temperature switches to monitor water and exhaust temperatures, modulating gas valve and freeze protection to protect the heat exchanger, and an overheat cutoff fuse.
12. The heaters can manifold up to 16 units (Common vented up to 8 units) to provide additional capacity.
13. The Ready-Link controls shall be built onto the onboard solid-state printed circuit board and does not require external controls. The linking control wire and common vent collar shall be supplied with the heater.
14. The Ready-Link and Controls shall modulate the system for the most efficient performance. The Ready-Link Controller shall rotate the priority heater based on hours of operation time for balanced duty/cycle operation.
15. The heater models are design certified by CSA according to ANSI Z21.10.3-2013, approved for sale in the United States, ENERGY STAR® qualified, has a minimum energy factor of 0.96, meets the energy efficiency requirements of the U. S. Department of Energy and ASHRAE 90.1, complies with SCAQMD Rule 1146.2 and other air quality districts with similar requirements for low NOx emissions of 14 ng/J or 20 ppm, and shall be certified to NSF 5 Standards.

B. Recirculation for the Rack system and building will be as shown with primary recirculation pumps located in the Navien tankless water heaters.

C. The system shall be provided with the two-way valves set to external recirculation, an internal buffer tank, and secondary building recirc pump located externally.

D. Secondary building recirc pump shall be wired for continuous running.

E. The Navien control systems shall be programed to test loop water temperature every 10 minutes (field programmable) and maintain loop temperature as required by owner.

F. Water shall be drawn from the recirculation loop and hot water injected back into the domestic hot water supply piping as needed.

G. The Tankless Water Heater portion of the domestic hot water recirculation system shall be capable of being shut off during unoccupied times with the programming.

H. The tankless water heater warranty with the controlled recirculation system shall be 1 year labor, 5 years parts and 8 years on the heat exchangers for commercial application.

I. Provide Condensate neutralization tank, NAVIEN Model GXXX001325. OR approved equal.

J. Units shall be provided with a common vent. Refer to the “Common Vent Installation Manual” for the NPE240-A2 Condensing Water Heater.

2.7 GAS VENT SYSTEM

A. Provide Type-B gas vent for water heaters, including roof flashing, vent cap and all materials for a complete installation as manufactured by METALFAB, INC. or approved equal. Gas vent shall be UL-Listed.

B. The vent shall be of the double-wall, factory-built type for use with approved Category I appliances burning natural or LP gas, which produce flue gases exhausted at temperatures not exceeding 550º F.

C. The vent shall be constructed of an outer wall of .018" thick G-90 galvanized steel. The inner wall shall be constructed of .012" thick aluminum alloy. The vent shall include an integral, 1/4" thick annular insulating air space.

D. Edges of inner and outer walls shall be hemmed prior to final assembly to prevent pipe and fittings from having exposed sharp edges. Walls shall be attached to maintain spacing and prevent separation of inner and outer walls.

E. The vent pipe shall incorporate a push-tab locking system to prevent disassembly of vent during or after installation.

F. All fittings, flashing, storm collar, cap and appliance adapter required to install the vent shall be included.

G. Vent shall be tested and listed for a minimum clearance to combustibles of 1".

H. B-Vent shall be installed in accordance with the vent manufacturer's installation instructions, UL listing and state or local codes.

I. Warranty

1. Refer to Specification section 230100 for warranty information.

2.8 HOT WATER CIRCULATING PUMPS

A. In-line pumps shall be close-coupled all bronze construction with mechanical seals. Motor shall be open drip-proof. BELL & GOSSETT or approved equal.

2.9 THERMOMETERS

A. Thermometers shall be provided as indicated. WEKSLER INSTRUMENT, Type “AF”.

B. 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 thermal well in flow of fluid.

C. Thermometer range shall be 0-200°F for hot water.

2.10 THERMAL EXPANSION TANK

A. Provide a bladder type thermal expansion tank as manufactured by AMTROL, Model THERM-X-TROL or approved equal.

B. The expansion tank shall be welded steel, constructed, tested and stamped in accordance with section VIII, Division 1 of the ASME Code for a working pressure of 125 PSIG, factory air pre-charged and field adjustable. All welds conforming to ASME Section IX. All internal parts must comply with FDA regulations and approvals.

C. Each tank shall have a steel shell and an internal butyl/EPDM diaphragm to isolate the air charge from fluid.

PART 3 - EXECUTION

3.1 CONNECTIONS TO EQUIPMENT

A. Make plumbing connections to all equipment requiring connections. Make all connections according to manufacturer’s recommendations.

3.2 INSPECTION AND TESTS

A. The new plumbing system shall be tested by the Contractor in the presence of the Engineer. Governing authorities having jurisdiction shall be notified of test required by them and Final Acceptance of work shall be contingent upon their approval. At least 48 hours’ notice shall be

given prior to test. All costs of conducting test and furnishing necessary equipment for test shall be borne by the Contractor.

B. Upon completion of roughing-in and before setting fixtures, test new hot and cold water piping system at hydrostatic pressure of 100 psig and prove watertight at this pressure. Test water piping system to be concealed separately in same manner as prescribed for entire system.

C. Thoroughly clean and flush piping and apply chlorine solution to new system at least 3 hours to destroy nonspore-forming bacteria. Following chlorination, flush agent from system until water is both bacteriologically and chemically satisfactory to Public Health Officer.

D. If inspection or tests show defect, replace such defective work or materials and repeat inspection tests. Make repairs to piping with new materials. No caulking of screwed joints or holes shall be acceptable.

E. Test all gas piping at 50 psig with oil-free compressed air for 2 hours with no loss in pressure.

F. Clean equipment, pipe, valves and fittings of grease, metal cuttings and sludge accumulated by operations of system for testing. Stoppage or discoloration or other damage to parts of building, its finish or furnishings due to Contractor’s failure to properly clean piping system shall be repaired without cost to the Owner.

END OF SECTION 220500

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 22 and 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
Hartford	Boiler Insurance Company Regulations
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, structural and architectural 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 "Submittals", 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 Engineer, 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 videotaped by the Contractor and provided in DVD format. Two copies of the DVD shall be submitted to the Owner.

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. In addition, equipment manufacturer and Contractor shall provide a one-year material, labor and refrigerant warranty on all compressors. In addition, the manufacturer shall provide an extended 4-year material warranty on all compressors.

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 drain, 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.

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.

B. 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, DUCT SUPPORTS AND FIXTURE SUPPORTS

A. Provide pipe sleeves, hangers, supports, duct supports and fixture 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.

B. Install pipe sleeves and properly secure in place with grout where pipes pass through masonry or concrete and at all fire-rated assemblies. Pipe sleeves, except in footings, 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, floors and partitions shall be Schedule 40 steel pipe. Where pipes pass through waterproofing membranes, provide flashing sleeves with integral flashing flanges or clamping device of 16-ounce soft-sheet copper; extend at least 8" from sleeve. Thoroughly mop flashing flanges and shields into membrane.

C. Hang horizontal overhead runs of pipe with adjustable clevis-type hangers spaced not over 10 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. Inserts shall be cast iron or cast steel, of type to receive machine bolt in one horizontal direction. Hangers for copper tubing shall be copper plated where in contact with tubing. 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. Hang all horizontal overhead runs of pre-insulated refrigerant pipe with a pipe shield as manufactured by EATON B-LINE, series SNAP'N SHEILD or approved equal. Hang all horizontal overhead runs of field insulated refrigerant piping with a clamp assembly attached to strut as manufactured by EATON B-LINE, series B-LINE ARMAFIX CLAMPS or approved equal. Refrigerant pipe insulation shall be continuous through the clamp assembly. All refrigerant pipe supports shall be spaced not over 6 feet apart.

E. Gas piping, refrigeration piping and condensate piping on roof shall be supported by support blocks manufactured by ROOF TOP BLOX model RTB-01, or approved equal. The support blocks must be designed to eliminate roof penetrations, flashings or damage to roofing membrane. Support body shall be made of recycled UV-resistant Polypropylene Copolymer. Base platform material shall be 1" thick, 25psi, type 4 closed cell structural foam to distribute and evenly cushion loads. Support top surface shall have molded in pipe organizing saddles and strut mounting cradle. The top surface shall also have screw guide indents and engineered internal screw thread gripping feature. Block must accept up to 1/2" threaded rod using side entry nut slots to allow fast top side assembly and piping height adjustments or attachment of galvanized slotted steel strut channel. Supports for roof mounted gas piping shall be provided with a galvanized pipe roller and collar assembly, "ROL-05" for pipe sizes up to 3".

F. 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.

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

H. For roof mounted piping provide approved pipe supports every four feet for Polyvinyl Chloride (PVC), every six feet for copper, and every ten feet for gas piping. Provide polycarbonate

securing brackets model SCB07. Brackets shall secure support directly to the roof membrane with M-1 structural adhesive.

I. C-clamps or beam clamps shall be permitted to be attached to one leg of the bottom chord on bar joists provided that they only support ductwork and the load does not exceed 50 lbs. per hanger. For pipe support and loads greater than 50 lbs. per hanger, provide center mounted hangers. Refer to structural drawings for details.

J. 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 Section 230700 for details.

K. Support and fasten fixtures and equipment in an approved manner.

L. 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 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. Pipes passing through firewalls, smoke partitions, fire partitions, or floors 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.

B. Unions shall not be concealed in walls, ceilings, or partitions.

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 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. Accessory control wiring including, but not limited to interlock wiring for electric damper actuators (separate from DDC systems), equipment accessories for cooling towers, closed circuit coolers and remote equipment sensors shall be provided and 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.

N. The Mechanical Contractor shall be responsible for the installation and mounting of all duct smoke detectors in new and existing ductwork. The duct smoke detector shall be furnished and provided with all fire alarm wiring under Division 26. Any and all Temperature Control wiring shall be provided under Division 23. Refer to the mechanical drawings for locations in new ductwork. Refer to the electrical drawings for locations of existing detectors to be replaced. Coordinate the installation of the detectors with the Electrical and Automatic Temperature Control Contractors.

2.7 MACHINERY ACCESSORIES

A. Provide oil-level gages, grease cups and grease-gun fittings for machinery bearings as recommended by machinery manufacturer; where these lubricating means are not easily accessible, extend to locations as directed. Furnish all grease-gun fittings of uniform type.

2.8 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.

2.9 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.

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. 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.

G. Close pipe openings with caps or plugs during installation. Cover fixtures and 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 fixtures, materials and equipment and deliver in approved unblemished condition. 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.

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. Make copper tubing sweat joints with noncorrosive flux and lead-free solder recommended for service encountered or as indicated.

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

D. Where concrete foundations or pedestals or the extension of existing 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”.

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

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

G. 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.

H. 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.

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. Where extension of existing concrete pad is required, concrete shall conform to requirements of Section 033000 “Cast-In-Place Concrete”.

3.7 FLASHING

A. Provide cap flashing for roof-mounted fans, goosenecks, air intakes, vents 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., Indoor Air Handling Units, Energy Recovery Unit, Variable Air Volume Terminal Boxes, Ceiling Cabinet Exhaust Fans, Cabinet Unit Heats, Split System Indoor Units, Boilers, Pumps, 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., Rooftop Units, Exhausts Fans, Split System Condensing Units, 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: packaged rooftop air conditioning units, indoor packaged air handling units, energy recovery units, boilers, pumps, etc.

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. Provide adequate access to all points of measurement and adjustment and ensure that all dampers operate freely.

E. 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.

F. 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.

G. 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. 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. In addition, all non-potable water systems shall be identified with outdoor grade 3.2 mil thick high gloss adhesive backed vinyl labels with the words, “Non-potable- not safe for drinking”. All non-potable water outlets, such as hose bibbs at low point drains, shall be identified with 1-1/2” diameter, permanently stamped, brass tags with the words, “Non-potable- not safe for drinking”.

E. Refrigerant piping service shall be indicated with outdoor grade 3.2 mil thick high gloss adhesive backed vinyl labels which identify the service by name (not initials). Provide labels similar to Brimar, EZ Pipe Markers. Labels shall be used wherever piping is exposed, at all unit connections and at 25-foot intervals for concealed piping located above accessible ceilings. Label and arrow heights shall be 1".

F. 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.

G. Provide seals, signs and tags on fire protection equipment at designated locations per NFPA.

H. 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, fans, pumps, and rooftop units.

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.

3.13 EQUIPMENT INVENTORY

A. Provide a complete equipment inventory for all Mechanical, Plumbing, and Fire Protection 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:_____.

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 Section 230900 “Automatic Temperature Controls”, and the on-drawing Sequences of Operation 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 rooftop units, water source heat pumps, 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. 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. 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. 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.

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". Approved equal by LAARS, CLEAVER-BROOKS, and AERCO. NO SUBSTITUTIONS.
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 interior with a carbon steel shell and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 16,000 to 20,000 Btu's per tube. The Wave Fire Tube shall be manufactured via a liquid impact process. The Wave Fire Tube shall have an OD = 1.654" and a wall thickness = 0.039". The top and bottom tubesheets shall have a minimum thickness = 3/8". There shall be no overlapping welds with the Wave Fire Tube to tubesheet welds. 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 copper tube or water 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 6.5 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than 156 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. 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

13. Trim:

    a. Safety Relief Valve:

        1) Size and Capacity: 50 psi
        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.

14. Controls:

a. Boiler controls shall feature a standard, factory installed 8" LCD screen display with the following standard features:

1) 8" LCD screen display displaying status, modulation percentage, setpoints, and sensor data at a minimum on the home screen. Additional information such as history and parameters can be accessed via the touchscreen display without the need for navigation buttons. A screen saver mode shall be available with the display.
2) Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
3) Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
4) 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.
5) Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
6) 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.
7) PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
8) 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.
9) 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.
10) 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.
11) Night setback: Boiler shall be programmed to reduce the space heating temperature set point during a certain time of the day.
12) 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.
13) 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.
14) 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.

b. 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: The Control module shall minimize the number of boilers firing to achieve the heating load.
2) Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.
3) 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.
4) Redundancy: The Control module shall have a built-in feature to continue operating with follow boilers if the Lead boiler is not operational.

c. 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 10 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 110 deg F.

d. 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.

15. Building Automation System Interface: Factory installed BACnet MSTP gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.

16. Software Update: The control shall have the ability to receive updates in the field without hardware component replacement. This update can be performed via USB flash drive,

internet connection, or via wireless connection. This service shall be provided at no additional and/or annual cost to the owner.

17. 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.

18. 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 and Water Heater Vent System:

1. Vents shall be Saf-T Vent CI Plus as manufactured by HEATFAB, INC., SCHEBLER, 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 AIR HANDLING EQUIPMENT

A. Air Handling Units (AHU-1, 2, 6, 7, and 8)

1. Provide size, type, and capacity Air Handling Unit as indicated. Basis of Design unit by YORK, alternate by TRANE or approved equal by CARRIER or AAON. NO SUBSTITUTIONS.

2. Warranty

   a. Refer to Specification Section 230100 for warranty requirements.

3. General:

   a. AHU shall consist of a structural base, insulated casing, access doors, fans, motors, motor controls, coils, filters, dampers, controls, components, and accessories as shown on drawings, schedules, and specifications.
   b. AHU shall maintain structural integrity when wall panels are removed.
   c. For segments that must be broken down for rigging and installation, segments shall be disassembled and reassembled by manufacturer's factory-trained service personnel.
   d. Manufacturer shall perform a field leakage test to confirm 1% maximum leakage as described in this Specification Section. Manufacturer shall provide a written statement confirming that the unit is built to the manufacturer's factory standards and that the unit will carry the full warranty.

4. Base Rail:

   a. Unit shall be provided with structural base rail under the full perimeter of the unit, formed from mill galvanized steel.
   b. Structural steel shall be installed providing clearance for proper trapping of drain pans.
   c. Units shall be provided with base rail and lifting lug system that does not require additional support for rigging. Include base rail lifting lugs at unit corners.

5. Cabinet:

   a. Casing panels shall be 2" double-wall construction with thermal. Thermal break shall be between interior and exterior liner of the panel assembly and between the panel and casing framework.
   b. Unit shall be of modular construction and shipped in sections that can fit through a standard 6'0" doorway. Units shall be field assembled. Assembly shall be

monitored by a factory trained technician and shall meet all factory construction standards once assembled. Units shall be leak tested and shall meet Factory leakage standards.

c. Panel assembly shall meet UL Standard 1995 for fire safety and comply with the requirements of NFPA 90A.
d. Access panels / doors: Unit shall be equipped with factory installed, powder coated painted steel, insulated, hinged doors. Doors shall be equipped with quarter-turn latching handles, guard, and tight air and water seal.

6. Coils:

a. Coils shall be provided with performance certified in accordance with AHRI Standard 410 for coil capacity and pressure drop wherever applicable. Coil circuits shall be designed such that the fluid velocity is within the range of certified rating conditions at design flow.
b. Coils shall be operable at 325 psig working pressure and up to 250 °F. Factory test coils with 325 psig compressed air under water. Coils shall conform to UL-207 Section 12.3.
c. Coils shall be aluminum plate fin and seamless copper tube in galvanized steel casing.
d. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded stainless steel sheet. Drain pan shall be a minimum of 2 inches deep, and sloped.

7. Fans:

a. Mount the fan and motor assembly on a common adjustable base. This common base shall attach to vibration isolators, which mount to structural support channels. These channels shall span the AHU floor and mount directly to the AHU frame.
b. Supply air and exhaust air blower assemblies shall consist of an electric motor and direct drive variable speed plenum fans. Supply fan shall be equipped with an air proving switch and integral over-temperature protection.
c. Plenum fan blades shall be aluminum backward-inclined airfoil.
d. Motor shall be electronically commutated.
e. Fans shall be constructed of corrosion resistant galvanized steel. Aluminum components shall be unpainted.
f. All fans shall be run tested at the specified operating speed and shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96.

g. Where applicable, (AHU-1 and 2) fan arrays of multiple direct-drive plenum fans shall conform to AMCA test standards 210 and 300 and shall bear the AMCA certified ratings seals.

1) Fans shall be unhoused and incorporate a non-overloading type backward inclined airfoil blade wheel, heavy-gauge galvanized G90 steel inlet plate and structural steel frame.
2) Wheels shall be constructed of non-overloading extruded airfoil shaped blades and shall be continuously welded.
3) Fan arrays shall be provided with fan inlet screen, fan discharge cage,

piezometer ring, and backdraft damper.

4) Fans shall be controlled by a common VFD.
5) All fan motors shall be factory-wired to individual manual motor protection devices (MMP). MMPs shall be contained in a single control panel with a single point of connection for input power wiring.

8. Motors:

   a. General: Blower motors greater than ¾ horsepower shall be "NEMA Premium™" unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure.

9. Phase and Brownout Protection: AHU shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.
10. Units with MOCP of 60 or greater shall be provided with a 65kAIC SCCR. Otherwise, provide with a 5kAIC SCCR.
11. Outdoor Air and Return Air Mixing Dampers: Dampers shall be opposed blade galvanized steel dampers with concealed blade to blade linkage and permanently lubricated bearings. Leakage rate shall not exceed 4 cfm/ft² at 1 in w.g. in accordance with AMCA Standard 500 and shall comply with AHSRAE 90.1.
12. Dirty Filter Alarm: Filter differential pressure switch with sensor tubing on either side of the filter shall be factory installed. The alarm and all related controls integration shall be provided by the Controls Contractor.

13. Unit Controls:

   a. The unit shall be controlled through the Building Automation System. Refer to Specification 230900 and the on-drawing points lists and sequence of operation.
   b. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified conditions can be input by means of pushbuttons on the unit controller. Note: DDC controllers that require the use of separately-purchased handheld hardware or a PC and/or software to view or change settings are not allowed.
   c. AHU supply fan shall be configured for Variable Air Volume
   d. Economizer control shall be based on outside air temperature.
   e. Dirty filter sensor shall be factory-installed.
   f. Operating protocol: The DDC shall be factory-programmed for BACnet MSTP.
   g. Airflow monitoring required in the Supply airstream.

14. Filters:

   a. Outside Air Filter: Shall be an aluminum, metal mesh, reusable air filter with

holding frame.

b. Supply Air Pre-Filter: Shall be factory fabricated, self-supported, pleated, panel-type disposable MERV-8 air filters with holding frame.
c. Supply Air Final Filter: Shall be factory fabricated, self-supported, pleated, panel-type disposable MERV-13 air filters with holding frame.

15. Energy Recovery (AHU-1, 2, 6, and 8):

a. Unit shall contain an energy recovery cabinet with outside air opening, exhaust air opening, return air opening, and supply air opening.
b. Outside air filters shall be provided upstream of the wheel.
c. Energy recovery wheel shall be factory mounted and tested.
d. The energy recovery wheel shall be a rotary wheel in an insulated cassette frame complete with seals, drive motor, and drive belt.
e. Wheels shall be provided with removable energy transfer matrix.
f. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set.
g. The energy recovery cassette shall be a UL recognized component for electrical and fire safety. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84 and AHRI Standard 1060.
h. Energy recovery wheel cassette shall carry a 5 year warranty from the date of original equipment shipment from the factory.
i. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade or require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
j. Wheel motor and speed control devices shall be factory provided and installed. Points shall be made available for integration with the BAS by the Controls Contractor.

B. Rooftop Air Handling Units (RAHU-3 and 4)

1. Provide size, type, and capacity Air Handling Unit as indicated. Basis of Design unit by YORK, alternate by TRANE or approved equal by CARRIER or AAON. NO SUBSTITUTIONS.

2. Warranty

a. Refer to Specification Section 230100 for warranty requirements.

3. General:

a. RAHU shall consist of a structural base, insulated casing, access doors, fans, motors, motor controls, coils, filters, dampers, controls, components, and accessories as shown on drawings, schedules, and specifications.
b. RAHU shall maintain structural integrity when wall panels are removed.

c. RAHU shall be fully assembled at the factory.

4. Base Rail:

a. Unit shall be provided with structural base rail under the full perimeter of the unit, formed from mill galvanized steel.
b. Structural steel shall be installed providing clearance for proper trapping of drain pans.
c. Units shall be provided with base rail and lifting lug system that does not require additional support for rigging. Include base rail lifting lugs at unit corners.

5. Cabinet:

a. Casing panels shall be 2" double-wall construction with thermal. Thermal break shall be between interior and exterior liner of the panel assembly and between the panel and casing framework.
b. Unit shall be fully assembled at the factory and consist of double-wall insulated panels, with joints sealed. Space between panel faces shall be filled with 2-inch insulation and sealed for R-13 performance. Internal panels hall be galvanized steel.
c. Panel assembly shall meet UL Standard 1995 for fire safety and comply with the requirements of NFPA 90A.
d. Access panels / doors: Unit shall be equipped with factory installed, powder coated painted steel, insulated, hinged doors. Doors shall be equipped with quarter-turn latching handles, guard, and tight air and water seal.

e. Provide RAHUs with a roof system that deflects no more than L/240 when subjected to a static snow load of 30 lb./ft^2. "L" is defined as the panel-span length and "L/240" is the deflection at the panel midpoint.

1) Roof system shall be sloped with a minimum pitch of 1/8" per foot.
2) Roof system shall overhang side and end panels by a minimum of 2".
3) Doors shall have drip edge guard above door frame, extending 2" beyond door surface.

6. Coils:

a. Coils shall be provided with performance certified in accordance with AHRI Standard 410 for coil capacity and pressure drop wherever applicable. Coil circuits shall be designed such that the fluid velocity is within the range of certified rating conditions at design flow.
b. Coils shall be operable at 325 psig working pressure and up to 250 °F. Factory test coils with 325 psig compressed air under water. Coils shall conform to UL-207 Section 12.3.
c. Coils shall be aluminum plate fin and seamless copper tube in galvanized steel casing.
d. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded stainless steel sheet. Drain pan shall be a minimum of 2 inches deep, and sloped.

7. Pipe Chase Cabinet:

    a. Provide pipe chases with double wall, insulated panels with the same thermal performance as the unit casing.
    b. Provide a perimeter base rail under the pipe chase that meets requirements for the RAHU base rail.

8. Fans:

    a. Mount the fan and motor assembly on a common adjustable base. This common base shall attach to vibration isolators, which mount to structural support channels. These channels shall span the RAHU floor and mount directly to the RAHU frame.
    b. Supply air and exhaust air blower assemblies shall consist of an electric motor and direct drive variable speed plenum fans. Supply fan shall be equipped with an air proving switch and integral over-temperature protection.
    c. Plenum fan blades shall be aluminum backward-inclined airfoil.
    d. Motor shall be electronically commutated and fans shall be direct-driven.
    e. Fans shall be constructed of corrosion resistant galvanized steel. Aluminum components shall be unpainted.
    f. All fans shall be run tested at the specified operating speed and shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96.
    g. Fans shall be provided with inlet screens on the inlets of fan housing and fan cage on discharge of fan housing.

9. Motors:

    a. General: Blower motors greater than ¾ horsepower shall be "NEMA Premium™" unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure.

10. Phase and Brownout Protection: AHU shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.
11. Units with MOCP of 60 or greater shall be provided with a 65kAIC SCCR. Otherwise, provide with a 5kAIC SCCR.
12. Outdoor Air and Return Air Mixing Dampers: Dampers shall be opposed blade galvanized steel dampers with concealed blade to blade linkage and permanently lubricated bearings. Leakage rate shall not exceed 4 cfm/ft² at 1 in w.g. in accordance with AMCA Standard 500 and shall comply with AHSRAE 90.1.
13. Dirty Filter Alarm: Filter differential pressure switch with sensor tubing on either side of the filter shall be factory installed. The alarm and all related controls integration shall be provided by the Controls Contractor.

14. Unit Controls:

    a. The unit shall be controlled through the Building Automation System. Refer to

Specification 230900 and the on-drawing points lists and sequence of operation.

b. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified conditions can be input by means of pushbuttons on the unit controller. Note: DDC controllers that require the use of separately-purchased handheld hardware or a PC and/or software to view or change settings are not allowed.
c. AHU supply fan shall be configured for Variable Air Volume
d. Economizer control shall be based on outside air temperature.
e. Dirty filter sensor shall be factory-installed.
f. Operating protocol: The DDC shall be factory-programmed for BACnet MSTP.
g. Airflow monitoring required in the Supply airstream.

15. Filters:

    a. Outside Air Filter: Shall be an aluminum, metal mesh, reusable air filter with holding frame.
    b. Supply Air Pre-Filter: Shall be factory fabricated, self-supported, pleated, panel-type disposable MERV-8 air filters with holding frame.
    c. Supply Air Final Filter: Shall be factory fabricated, self-supported, pleated, panel-type disposable MERV-13 air filters with holding frame.

16. Exterior Finishes:

    a. Exterior surfaces shall be cleaned prior to application of exterior protective coating.
    b. Manufacturer shall paint exterior surfaces of outdoor units prior to shipment.

        1) Manufacturer shall apply a primer prior to application of finish coating.
        2) Exterior finish coating shall show a breakdown of less than 1/8” on either side of a scribed line when subjected to ASTM B117 2,000 hour, 5% salt spray conditions. This is equivalent to an ASTM D1654 rating of ‘6.’ Also, per ASTM D610, degree of rusting to meet #8-G and per ASTM D714 degree of blister to meet #6 medium.

17. Energy Recovery (RAHU-3):

    a. Unit shall contain an energy recovery cabinet with outside air opening, exhaust air opening, return air opening, and supply air opening.
    b. Outside air filters shall be provided upstream of the wheel.
    c. Energy recovery wheel shall be factory mounted and tested.
    d. The energy recovery wheel shall be a rotary wheel in an insulated cassette frame complete with seals, drive motor, and drive belt.
    e. Wheels shall be provided with removable energy transfer matrix.
    f. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set.
    g. The energy recovery cassette shall be a UL recognized component for electrical

and fire safety. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84 and AHRI Standard 1060.

h. Energy recovery wheel cassette shall carry a 5 year warranty from the date of original equipment shipment from the factory.
i. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade or require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
j. Wheel motor and speed control devices shall be factory provided and installed. Points shall be made available for integration with the BAS by the Controls Contractor.

C. Energy Recovery Unit (ERU-1)

1. Provide size, type, and capacity Air Handling Unit as indicated. Basis of Design unit by AAON, alternate by TRANE or approved equal by CARRIER or YORK. NO SUBSTITUTIONS.

2. Warranty

a. Refer to Specification Section 230100 for warranty requirements.

3. General:

a. Indoor air handling unit shall include filters, supply fan, chilled water coil, hot water coil, exhaust fan, and energy recovery wheel.
b. Unit shall have a draw-through supply fan configuration and discharge air vertically.
c. Unit shall be fully assembled at the factory.

4. Construction:

a. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
b. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, reduces heat transfer through the panel and prevents exterior condensation on the panel.
c. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
d. Access doors shall be flush mounted to cabinetry.

e. Units shall include double-sloped 304 stainless steel drain pan. Drain pan connection shall be on the right hand side of unit with a 1" MPT fitting.
f. Cooling coil shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.
g. Unit shall be provided with a high condensate level switch that shuts down the unit when a high water level is detected in the drain pan.
h. Unit shall include factory wired control panel compartment LED service lights.

5. Electrical:

a. Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Both side walls of the control panel shall include louvered vents. Control panel shall be field mounted and shall include a piano hinged service access door with tooled entry.
b. Unit shall be provided with standard power block for connecting power to the unit.
c. Unit shall include a factory installed 24V control circuit transformer.
d. Unit shall have a 5kAIC SCCR.
e. Unit shall include high and low voltage quick connects for easy wiring at installation.
f. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.
g. Unit shall be provided with remote safety shutdown terminals for wiring to a field installed smoke detector, firestat, or building safety automatic shutdown system.

6. Supply Fans

a. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
b. Blower and motor assembly shall be dynamically balanced.
c. Motor shall be an IE5 efficiency permanent magnet totally enclosed motor.
d. Blower and motor assembly shall be mounted on rubber isolators.
e. ECM driven supply fan shall include a factory installed potentiometer within the control compartment for cfm setpoint. The factory provided terminal block shall include a jumper wire that can be removed when wired to field provided 0-10 VDC control signal.

7. Exhaust Fans:

a. Unit shall include direct drive, unhoused, backward curved, plenum exhaust fans.
b. Blower and motor assembly shall be dynamically balanced.
c. Motor shall be a high efficiency electronically commutated motor (ECM).
d. Blower and motor assembly shall utilize neoprene gasket.
e. Access to exhaust fan shall be through an access door with removable pin hinges and lockable quarter turn handles.
f. ECM driven exhaust fan shall include a factory installed potentiometer within the control compartment for cfm setpoint. The factory provided terminal block shall include a jumper wire that can be removed when wired to field provided 0-10 VDC control signal.

8. Cooling Coil:

    a. Access to cooling coil shall be through hinged access door with lockable quarter turn handles.

    b. Chilled Water Cooling Coil:

        1) Coil shall be certified in accordance with AHRI Standard 410 and be hydrogen leak tested.
        2) Coil shall be designed and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
        3) Coil shall have quarter serpentine circuitry, 6 rows and 10 fins per inch.
        4) Coil shall have right hand external piping connections. Supply and return connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.
        5) Control valves shall be field supplied and field installed.

    c. Air handling unit and matching condensing unit shall be capable of operation as an R-410A split system air conditioner.

9. Heating Coil:

    a. Coil access shall be through service access door with piano hinges and lockable quarter turn handle.

    b. Hot Water Heating Coil:

        1) Coil shall be certified in accordance with AHRI Standard 410 and be hydrogen leak tested.
        2) Coil shall be designed and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
        3) Coil shall have quarter serpentine circuitry, 2 row and 10 fins per inch.
        4) Coil shall have right hand external piping connections. Supply and return connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.
        5) Control valves shall be field supplied and field installed.
        6) Coils shall be located in the reheat position downstream of the cooling coil.

10. Filters:

    a. Unit filter access shall be through service access door with piano hinges and quarter turn button fasteners.
    b. Unit shall include 2 inch thick, pleated panel filters with MERV rating of 8, upstream of the cooling coil.

11. Energy Recovery:

    a. Unit shall contain an energy recovery cabinet with back outside air opening, back exhaust air opening, top return air opening, and top supply air opening.
    b. Unit shall include 2 inch thick, pleated panel outside air filters with MERV rating of 8, upstream of the wheel.
    c. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
    d. Wheel frame shall slide out for service and removal from the cabinet.
    e. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
    f. Wheels shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
    g. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
    h. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
    i. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.
    j. Energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Airxchange. The 5 year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the Airxchange written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts. Refer to the Airxchange Energy Recovery Cassette Limited Warranty Certificate.
    k. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade

desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

l. Energy recovery wheel access shall be through service access door with piano hinges and quarter turn button fasteners.

12. Controls:

a. The unit shall be controlled through the Building Automation System. Refer to Specification 230900 and the on-drawing points lists and sequence of operation.

D. Exhaust Fans:

1. Fans shall be size, type, and have capacity as indicated on drawings. GREENHECK, LOREN COOK, TWIN CITY, ACME or approved equal.
2. 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 or belt drive as indicated. Shaft shall be mounted in ball bearing pillow blocks. Bearings shall have grease fittings. Units shall be provided with direct drive motor and solid-state speed controls. AC induction type motors are not acceptable for direct drive fans.
3. Cabinet Inline Exhaust Fans: Fans shall be constructed of galvanized steel, with forward curved direct-drive centrifugal fans. Motor shall be a DC electronic commutation type motor (ECM) specifically designed for fan applications. Provide factory-wired plug-type disconnect, gravity back-draft damper and vibration isolators. Fan housing shall be of the square design, constructed of heavy gauge galvanized steel and shall include duct mounting collars.
4. Ceiling Cabinet Exhaust Fans: Fans shall be constructed of heavy gauge galvanized steel, with forward curved centrifugal wheel constructed of calcium carbonate filled with polypropylene. Motor shall be permanently lubricated sleeve bearing type to match with the fan load and furnished at the specified voltage and phase. Motors shall be compatible for use with speed controls and provided with thermal overload protection. Provide factory-wired pug-type disconnect, aluminum gravity back-draft damper, and ceiling grille.
5. 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.
6. All fans shall be statically and dynamically balanced.
7. Install as required for quiet operation.

2.3 UNITARY EQUIPMENT

A. Ductless Split System Heat Pump Units (SS-1 IU and OU, SS-2 IU and OU, SS-3 IU and OU):

1. The heat pump system shall be an LG or MITSUBISHI Electric split system with variable speed inverter compressor technology. Basis of Design is LG. The system shall consist of a wall mounted indoor section with a wired, wall mounted, remote controller and a matched capacity, horizontal discharge, single phase outdoor unit.

2. Quality Assurance:

   a. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.
   b. All wiring shall be in accordance with the National Electrical Code (NEC).
   c. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 240 and bear the ARI Certification label.
   d. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
   e. A dry air holding charge shall be provided in the indoor section.
   f. The outdoor unit shall be pre-charged with R-410a refrigerant for 70 feet (20 meters) of refrigerant tubing.
   g. System efficiency shall meet or exceed 13.6 SEER.

3. Delivery, Storage and Handling:

   a. Unit shall be stored and handles according to the manufacturer's recommendations.
   b. The wireless controller shall be shipped inside the carton with the indoor unit and able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

4. Warranty:

   a. The units shall have a manufacturer's parts and defects warranty for a period one (1) year from date of installation. The compressor shall have a warranty of 6 years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.
   b. Manufacturer shall have over 25 years of continuous experience in the U.S. Market.

5. Indoor Unit:

   a. The indoor unit cabinet shall be wall or ceiling mounted as indicated on the drawings. Wall mounted units shall be hung by means of a factory supplied mounting plate. The cabinet shall be formed from high strength molded plastic with front panel access for filter. Cabinet color shall be white – Munsell 0.70 8.59/097.
   b. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor.

c. The unit in conjunction with the wired, wall-mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.
d. Fan: The evaporator fan shall be high performance, double inlet, forward curve, direct drive sirocco fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of four (4) speeds: Low, M1, M2, and Hi.

6. Vane:

a. There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower noise levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.

7. Filter: Return air shall be filtered by means of an easily removable washable filter.
8. Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.
9. Condensate Lift Pump: The condensate pump shall be Little Giant, model EC-OP or approved equal.

10. Electrical:

a. The electrical power of the unit shall be 208/230 volts, 1-phase, 60 hertz.
b. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
c. The indoor unit shall be provided with A-Control – a system allowing the indoor unit to be powered and controlled directly from the outdoor unit using a 14 gauge (AWG) 3-wire connection plus ground providing both primary power and integrated, by-directional, digital control signal without additional connections.
d. The indoor units shall not have any supplemental or “back-up” electrical heating elements.

11. Control:

a. The control system shall consist of two (2) microprocessors, one in each indoor and outdoor unit, interconnected by A-Control. This three (3) conductor 14 ga. AWG wire with ground method shall provide power feed and bi-directional digital control transmission between the outdoor and indoor units.
b. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller display panel.
c. The microprocessor located in the indoor unit shall have the capability of monitoring

return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and for controlling the operation of the outdoor unit.

d. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD) presenting contents in eight (8) different languages, including English, French, Chinese, German, Japanese, Spanish, Russian, and Italian.
e. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Auto/Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C).
f. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e., liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.
g. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. Temperature sensing shall be done by a Thermistor mounted in the return air stream of the indoor unit. An alternate temperature sensor shall be located within the wall controller. Selection of the sensor is by switch in the indoor unit. The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,650 feet (500 meters).
h. The control voltage from the wired controller to the indoor unit shall be a digital +/- 24 volts, DC signal. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.
i. Control system s hall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds' delay.
j. A two wire (one pair) twisted, stranded, 18 gauge (AWG), jacketed, control cable shall be used to connect the controller to the indoor unit.

12. Outdoor Unit:

a. The outdoor unit shall be compatible with ARNU type indoor units. The connected indoor unit must be of the same capacity as the outdoor unit.
b. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.
c. The outdoor unit shall be capable of operating at 0°F (-18°C) ambient temperature without additional low ambient controls (optional wind baffle may be required).
d. The outdoor unit shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.
e. The system shall have a maximum refrigerant tubing length of 100 feet.

f. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.

g. Cabinet: The casing shall be constructed from galvanized steel plate, coated with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a Munsell 3Y 7.8/1.1 finish. The fan grill shall be of ABS plastic.

h. Fan: Unit shall be furnished with fan AC fan motor. The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.

i. The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be controlled by a microprocessor-controlled step motor.

j. The compressor shall be a DC rotary compressor with Variable Compressor Speed Inverter Technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating the in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain sufficient heat. The outdoor unit shall have an accumulator and high-pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

2.4 TERMINAL EQUIPMENT

A. Cabinet Unit Heater: (CUH-A):

1. Units shall be size, type, and have capacity as indicated. Provide units manufactured by IEC, MARKEL, TRANE, or approved equal. Basis of Design is IEC.
2. Cabinet: The cabinet shall be made of heavy 18-gauge galvanized steel. The interior surface shall be lined with 1/2" foil faced insulation. Insulation and adhesive shall meet NFPA-90A requirements for flame spread and smoke generation. Top panel shall be provided with a stamped supply grille and shall be painted to match cabinet. Cabinet shall include two access doors.
3. Coils: Coils shall have 1/2" copper tubes, automatic air vent(s), aluminum fins, galvanized end sheets, and be 10 fins per inch. Coil fins shall be mechanically bonded to copper tubes. Copper tubes shall comply with ASTM B-75.
4. Valves: Unit shall be equipped with valve package including manual ball valves for service, motorized control valve, strainer, balancing valve, etc.
5. Motor and Blower Assembly: Fans shall be direct-drive, double-width fan wheels with forward-curved blades. Blower wheels shall be statically and dynamically balanced. Scrolls and fan wheels shall be constructed of galvanized steel and shall be easily removable. Motors shall be 3-speed, single phase, 60Hz, constant torque EC motors with means for 4 speed solid state potentiometer field adjustments and permanently lubricated

ball bearings. Motors shall be connected with quick connect electrical plugs and shall have internal thermal overload protection with automatic reset.

6. Controls: Units shall be equipped with 24V controls.

B. Unit Heaters (UH-A):

1. Unit shall be size, type, and have capacity as indicated. Provide units manufactured by IEC, TRANE, MARKEL, or approved equal. Basis of Design is IEC
2. Unit shall be complete, including casing, electric heating coil, fans, fan motor, built-in disconnect switch, integral thermostat filters, and baked-enamel cabinet in color selected by Architect.
3. Construction: Heavy 18 Gauge welded steel cabinet with powder coated finish and control compartment housing a master terminal board with a hinged and latched access door, simplifying wiring, installation & maintenance.
4. Heating Element: Copper clad steel sheath element with continuously brazed steel fins formed to allow side draw through air flow.
5. Motor and Blower Assembly: Totally enclosed, 1-speed, 1-phase, permanently lubricated, thermally protected motors with unit bearings. Motor shall be mounted with rubber insulators to minimize vibration & noise. Fan over-ride purges unit of residual heat at shutdown.
6. Louver Assembly: Louvers are individually adjustable for directional control of air flow up to 15° from straight horizontal.
7. Installation: Unit Heater shall be mounted for horizontal discharge.

C. Electric Duct Heater (DHC-1):

1. Units shall be size, type and have capacity as indicated provided by YORK, TRANE, ABOVE AIR, MARKEL, Q-MARK or approved equal. Basis of Design is YORK.
2. Units shall be open coil, electric duct heaters. Heater shall be flanged type.
3. All heaters shall meet the requirements of NEC.
4. All heating coils to be made of high grade Nickel/Chromium resistance wire and terminated by means of crimped stud with stainless steel or nickel plated terminal hardware.
5. Unit shall be provided with primary high limit temperature protection.
6. Heater shall be provided with SCR modulation control.

D. Fan Coil Unit (FCU-1):

1. Units shall be size, type, and have capacity as indicated provided by IEC, TRANE, MCQUAY, or approved equal. Basis of Design is IEC.
2. Units shall be complete, including casing, copper-tube/aluminum-fin heating and cooling coils, fans, fan motors, filters, and supply and return duct collars.
3. Motors shall be multi-speed, permanent-split-capacitor type with built-in overload protection.
4. Filters shall be 1” thick, throwaway type.
5. Provide speed control switch pre-wired to motor.
6. Provide with factory-installed condensate overflow switch.

2.5 HVAC PIPING AND SPECIALTIES

A. Piping:

1. Water, Refrigerant, Gas, 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 and Hot water piping:

   a. Above Ground

      1) Type L copper (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. Condensate drain piping:

   a. Above ground (within building and plenum rated ceiling)

      1) Type L copper

   b. Above ground (exterior to building)

      1) Schedule 40 PVC

   c. Below ground: refer to Specification Section 220500 Plumbing

4. Refrigerant piping:

   a. Above ground

      1) Copper Type ACR

5. 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)

6. Drain piping in mechanical equipment rooms:

    a. Above ground

        1) Type L copper

7. 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.
8. Schedule 40 PVC pipe shall be assembled in strict accordance with manufacturer's instructions. Solvent cement shall conform to ASTM D2564.
9. Schedule 40 black steel pipe shall be fabricated by welding using Schedule 40 steel welding fittings conforming to ASTM A53.
10. ACR tubing shall be nitrogen-filled assembled with wrought-copper soldering fittings using silver solder.
11. 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.
12. Pitch hydronic piping to vent at high points and provide accessible drains at low points.

B. Valves:

1. Isolation valves shall be ball type for 2" and under and gate type for 2-1/2" and over. 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 piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Gate valves for water shall be solid-wedge type. Catalog numbers indicated below are NIBCO. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.

Size	**Pipe Material**	**Check**	**Ball**	Gate
2" and under	Copper	S-413-Y	S-585-70-66NS	——
2-1/2" and over	Steel	F918-B	———	F-619

2. Check valves in pump discharge lines shall be NIBCO F-910 "silent check valve". Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.

3. 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 in 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. Base Mounted End Suction Circulating Pumps (P-1, 2, 3, and 4):

1. Pumps shall be size, type, have capacity and arrangement as indicated, designed for service encountered. ARMSTRONG, or equal by BELL & GOSSETT or TACO. NO SUBSTITUTIONS.

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.

D. Inline Circulating Pump (P-5 and P-6):

1. Provide closed coupled inline permanently lubricated pump for hot water system as indicated on the drawings. Basis of design is ARMSTRONG or approved equal by BELL & GOSSETT or TACO. NO SUBSTITUTIONS.
2. The pumps shall be of a horizontal, permanently lubricated type, specifically designed for quiet operation. Suitable for 225ºF operation at 125 PSIG working pressure. The pump shall be single stage, closed coupled design, in cast iron bronze fitted construction. The pumps shall be composed of three separable components a motor, bearing assembly and

pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupler.

3. The pumps shall have a solid carbon steel shaft supported by two sealed ball bearings. A stainless-steel shaft sleeve shall be employed to completely cover the wetted area under the seal.
4. Pump shall be equipped with carbon or silicon carbide seal assembly.
5. Bearing assembly shall be sealed precision steel ball bearing, permanently lubricated.
6. Pump volute shall be of cast iron and lead-free bronze. The connection style on cast iron pumps shall be flanged. Volute shall include gauge ports as nozzles and vent and drain ports.
7. Motors shall meet scheduled horsepower, speed, voltage and enclosure design. Motor shall be resilient mounted. Motors shall have permanently lubricated ball bearings and must be completely maintenance free. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
8. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
9. Pump manufacturer shall be ISO-9001 certified and be of U.S. manufacturer.
10. Each pump shall be factory tested and name-plated before shipment and shall be provided with a three (3) year warranty from date of installation.

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 ARMSTRONG, KECKLEY, 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. Provide spool-type expansion joint, standard single-arch type, on suction and discharge piping of base-mounted pumps, and where indicated. KEFLEX, or approved equal.
2. Joints shall be constructed of abrasion-resistant rubber compounds, reinforced with steel rings and high-tensile strength fabrics. Flanges shall be steel.
3. Joints shall be installed so that they carry no piping load. Misalignment of piping shall not exceed 1/8".
4. Control rods shall be installed at each joint. Rods shall be attached with neoprene bushings to prevent transmission of noise and vibration.

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. ARMSTRONG "L Series" or equal by BELL & GOSSETT or 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. ARMSTRONG, 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 and hot 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 lower head to facilitate removal of assembly for inspection or cleaning.

J. Simplex Strainer:

1. Provide duplex strainer, Eaton model 50 Duplex or equal by TITAN. NO SUBSTITUTIONS.
2. Strainer shall be provided with flanged connection and shall have 1mm screen or 30 mesh screen.

K. Air Vents:

1. Provide manual air vents where indicated, and where required to properly and adequately vent chilled and hot water systems 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.) ARMSTRONG Model AVV-075, BELL & GOSSETT Model 107, or approved equal.

L. 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 and hot water.

M. Pressure Gauges:

1. Pressure gages shall be provided on suction and discharge line of each pump and where indicated. WEKSLER INSTRUMENT, model AA-14-2.
2. Gages shall be bourdon spring type with 4-1/2" dial set in polypropylene case. Gauges shall be equipped with brass tee-handle shut-off cocks. Gauges shall have required range of 0-100 psig and not in more than 2 psi graduations.

N. 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. All valves shall be factory leak tested at 100 psi air under water.
13. Ratings: 1/2" through 2" pipe size: 600 PSIG at 250°F
14. 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.
15. 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.
16. 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.
17. 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.
18. The standard ports and handles shall clear 1" thick insulation. Handle and port extensions are required for over 1" thick insulation.
19. 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.

O. Venturi Flow Measuring And Balancing Valves:

1. Provide venturi flow measuring and balancing valves where indicated, NuTech Model MB for pipe size 1/2" to 2" and Model MBF for sizes 2-1/2” and larger, or approved equal.
2. Balancing valves ½” thru 2” shall be constructed of bronze or brass. Valves shall be rated for 600 psi at 250°F. The valve ball ID shall be minimum standard port (one size smaller than valve connection size) Reduced port valves are not acceptable.
3. Sizes 2-1/2” and larger venturi flow meter and butterfly balancing valve shall be constructed of cast carbon-steel ASTM A120 with accurately machined throat. Provide 150-pound ANSI B16.5 flanged connections. Valves shall be rated at 200 psig at 250°F.
4. Butterfly valve shall be constructed of ductile-iron, lug-type body, ANSI Class 125/150, with EPDM seat and gasket, 416 stainless-steel stem, bronze sleeve bearing 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 or losing the balancing position valve sizes 2" thru 6".
5. Venturi section shall be low loss with a minimum accuracy of 3% of rate.
6. Valves shall be provided with pressure/temperature ports and memory stop. Valves shall

be equipped with metal tag and chain. Valves shall be supplied with extended handles and PT ports to clear insulation on chilled water service.

7. Valves shall be sized as indicated or as recommended by valve manufacturer for intended flow capacity.

P. Flow Stations:

1. Provide venturi flow meter as indicated. NUTECH Model MBF, 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. The entire assembly shall have been matched and laboratory tested for accuracy and shall have a 5-year warranty.
4. Total pressure drop shall not exceed one foot.
5. Flow rate increments shall be suitable for the indicated flow rate.

Q. Heat Trace:

1. The heater in combination with the interconnecting components shall be UL Listed. The self-regulating heater shall consist of two (2) #16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperatures all along its length, allowing the heater to be crossed over itself without overheating, to be used directly on plastic pipe and to be cut to length in the field. The heater shall be covered by a tinned-copper metallic over-shield and a thermoplastic elastomer over-jacket. The heater and equipment protection shall conform with NEC Code 2017 Article 427-22 & 23. The heater shall operate on line voltages as shown on the drawings without the use of transformers. The heater shall be selected by the manufacturer and installed to maintain a minimum water temperature of 35°F at an ambient temperature of -10°F.
2. The heater shall be as manufactured by HEAT TRACE PRODUCTS, LLC., 2700 Series, or an approved equal.

3. The heater shall be sized according to this table. The required heater output rating is in watts per foot at 50°F. (Heater selection based on 1" fiberglass insulation on metal piping).

Pipe Size	
6" or less	1 strip – 8 watts/lf

4. Power connection and seal, splice, and tee kit components shall be supplied by the manufacturer and applied in the field.
5. Heat trace circuit shall be controlled by a terminal controller. The controller shall be supplied and installed by the contractor. The controller shall be equipped with a pipe temperature sensor and a contact for alarm monitoring via the BAS. The controller shall enable the heater when a pipe temperature of less than 38°F is sensed. The controller shall disable the heater when a pipe temperature of greater than 38°F is sensed.
6. Each heat trace circuit shall be monitored by the BAS. The BAS shall monitor the heat trace system using the controller's integral alarm contact.

7. Run the heater linearly along the underside of the pipe after piping has been successfully pressure tested. Secure the heater to piping with fiberglass tape.
8. Install heating cable strictly in accordance with manufacturer's recommendations. Provide wrapping per manufacturer's recommendations for valves, fittings, etc. Also provide additional coverage for locations where pipe goes below grade.
9. Apply "electric traced" signs to the outside of the thermal insulation, one every 10 linear feet.
10. All piping that is protected by heating cable shall have insulation. Insulation shall extend 12" into heated space or 12" beyond the area where water normally stands in the pipe.
11. Coordinate the location and amperage of the heat tracing circuits with the Division 26 installer.
12. The Heat Trace equipment shall be provided with an Electronic Thermostat Control with Ground Fault Equipment Protection, as manufactured by DELTA-THERM model POWERTRACE etc1, or approved equal.
13. Contractor shall be responsible for a complete working system.
14. After installation and before and after installing the thermal insulation, subject heat tape to testing using a 1,000-VDC megger and 12-volt DC test to verify cable paths. Minimum insulation megger resistance reading should be 20 to 1,000 megohms regardless of length. Provide field test report to the Engineer after each successful test.

R. Chemical Shot Filter Feeder:

1. Provide one feeder for chilled and hot water system NEPTUNE Model FTF-5DB or approved equal.
2. Tanks shall be ASME Code construction for 125 psi service, 5-gallon chemical shot feeder.
3. Feeder shall include funnel, legs and isolation valves.
4. Provide with (2) 20 micron filter bag for immediate use and one for replacement.

S. Test Stations – Pressure/Temperature (PT):

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.

2.6 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 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 except for the following which may be Class B:

   a. Exhaust in conditioned spaces
   b. Supply duct <2" w.g. operating pressure in conditioned spaces
   c. Return duct in conditioned space

5. 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

6. 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.
7. 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.
8. 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

9. Fittings shall be of the following minimum gauges:

Nominal Duct Size	Inner/Outer Shell (Gauge)	Inner Shell (Gauge)
3-34	22	24

10. Round fittings may be spot welded and bonded.
11. Insulation shall have the following UL rating:

Flame Spread	10-20
Fuel Contributed	10-15
Smoke Developed	0-20

12. Round spiral duct and fittings shall be UNITED MCGILL CORPORATION, or equal by HAMLIN SHEET METAL, SEMCO MANUFACTURING, LINDAB, INC or EASTERN SHEET METAL.
13. Round ductwork shall not be delivered to the job site until just prior to erection. Ductwork with dents or other damages shall not be accepted.
14. 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.
15. 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.

16. Provide flexible connections of fiberglass between ducts and air-handling unit connections 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 "PROFLES^{TM}" or approved equal.

    Outdoor: U.V. resistant Hypalon coated glass fabric, minimum 24 oz./sq.yd. DUCTMATE "PROflex^{TM}" or approved equal.

17. 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[tm]" or approved equal.

18. Construct, brace, and support ducts and air chambers in a manner that they shall neither sag nor vibrate to any perceptible extent when fans are operating at maximum speed or capacity.
19. 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 shall 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.
20. Connect ductwork to intake and discharge louvers, dampers, and other work installed in various trades requiring sheet-metal connections.
21. Make sheet-metal connections to masonry work airtight and watertight in an approved manner.
22. 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.
23. Provide square to round transition fittings with balancing damper at all round-duct take-offs to supply diffusers and registers.
24. Duct sizes are inside free area. Increase duct sizes as required.
25. Ductwork and accessories shall not be delivered to the job site until just prior to erection and must be stored in an approved manner.
26. All ductwork shall be internally cleaned by vacuuming prior to installation.
27. All ductwork open ends shall be sealed with polyethylene and duct tape during construction after hanging.

B. Roof Curbs:

1. Roof Curbs shall be existing to remain.

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. Louvers:

1. Provide outside air louvers where shown on the plans. Louvers shall be GREENHECK Model EHH-201, wind-driven rain type or approved model from RUSKIN, or CONSTRUCTION SPECIALTIES. (NO SUBSTITUTIONS.)
2. Louvers shall be wind-driven rain type in a 2 in louver frame. Each factory-assembled louver section shall be designed to withstand wind loadings of 25 PSF (100.0 MPH wind equivalent). Louver frames, mullions, and section joints shall be adequately supported from the building structure to withstand this same wind loading. Welded construction is required to fasten the blades to the frame rather than standard screwed construction.
3. Louver performance data shall be licensed under the AMCA Certified Ratings Program and shall bear the AMCA Certified Ratings Seal. This certified performance data shall include airflow pressure loss and water penetration, and shall demonstrate performance equal to or better than the GREENHECK model specified.
4. Louvers shall be fabricated from 6063T5 aluminum extrusions of 0.125 in nominal wall thickness for both frame and blades. Blades shall be positioned at 37-degree and 45-degree angles approximately on 1 in centers. Each louver shall be equipped with a framed, removable, rear-mounted screen of 0.75 in x 0.051 in expanded, flattened aluminum.
5. Louvers shall be supplied with a Kynar finish applied following a thorough cleaning and pretreatment of the metal surface. Dry film thickness of the Kynar shall be approximately 1.2 mm after baking at 450 F. Color shall be selected by the architect. Forward color samples for review and selection.

E. Kitchen Ventilation System:

1. All components of the Kitchen Ventilation System shall be provided by a single vendor, including the kitchen exhaust fans, make up air system, and associated temperature control system. Kitchen Hood and fire suppression systems shall be existing to remain.

2. Kitchen Exhaust Fan (KEF-1):

   a. Furnish and install kitchen exhaust fan of size, type and capacity as indicated. Unit shall be as manufactured by CAPTIVEAIRE, ACCUREX, or equal.
   b. Construction: The fan shall be upblast centrifugal belt driven type. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. Wind bands shall have a rolled bead for added strength and shall be joined to curb caps with a leak proof, continuously welded seam. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
   c. Motor: 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. Motors shall be readily accessible for maintenance. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
   d. Wheel: 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.
   e. Roof Curb: Provide with manufacturer's roof curb to match existing roof openings. Roof curb shall be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit.

3. Makeup Air Unit (KMAU-1):

   a. Make-Up Air unit shall be as manufactured by CAPTIVEAIRE, or approved equal.
   b. Indirect-gas fired furnace shall be 80% efficient, ETL listed and have a blow through fan design. Furnace shall be capable of operation with Natural or LP gas and have a power venting system. The heat exchanger shall be constructed of aluminized steel or stainless steel. Standard furnace features shall include main gas pressure regulator, main gas valve, electronic staged or electronic modulating controls, direct spark ignition system, high limit and a 24-volt control transformer. Furnace shall be insulated and have double wall construction.
   c. Furnace heat output shall be controlled based on a field adjustable discharge temperature set point. Discharge temperature sensor shall be factory mounted and wired to the unit control center. Furnace shall have 16 stages of control.
   d. Unit shall be of internal frame type construction of galvanized steel. All frames and panels shall be G90 painted steel. Where top panels are joined there shall be a standing seam to insure positive weather protection. All metal-to-metal surfaces exposed to the weather shall be sealed, requiring no caulking at job site. All components shall be easily accessible through removable doors.
   e. Centrifugal fans shall be double width, double inlet. Fan and motor shall be mounted on a common base and shall be internally isolated. All blower wheels shall be statically and dynamically balanced. Ground and polished steel fan shafts shall be mounted in permanently lubricated ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged speeds.
   f. Motors shall be energy efficient, complying with EPACT standards, for single speed ODP and TE enclosures. Motors shall be permanently lubricated, heavy duty type, matched to the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be cast and have machined surfaces, 10 horsepower and less shall be supplied with an adjustable drive pulley.
   g. All internal electrical components shall be prewired for single point power connection. All electrical components shall be UL listed, recognized or classified where applicable and wired in compliance with the National Electrical Code. Control center shall include motor starter, control circuit fusing, control transformer for 24 VAC circuit, integral door interlocking disconnect switch and terminal strip. Contactors, Class 20 adjustable overload protection and single-phase protection shall be standard.
   h. Filters shall be mounted in a V-bank arrangement such that velocities across the filters do not exceed 550 feet per minute. Filters shall be easily accessible through a removable access panel.
   i. Weather hoods shall be constructed of G90 painted steel with PERMATECTOR with birdscreen mounted at the intake.
   j. Provide two position damper at outside air intake. Damper shall be open when the unit is running and closed when the unit is off.
   k. Provide welded aluminum unit roof curb. Curb shall be insulated with 1", 3lb. density insulation. Curb height shall be 18".

F. Kitchen Exhaust Ductwork:

1. The grease duct shall be single-wall or double-wall factory-built type for use with Type 1 kitchen hoods, as described in NFPA-96 for the transportation of air and grease-laden vapors from commercial cooking operation.

2. Product Description:

   a. Model PSW Grease Duct by METAL-FAB, SCHEBLER Chimney Systems FyreGuard, or approved equal.
   b. Factory pre-fabricated, single-wall type, listed for venting of grease laden air from kitchen hoods requiring grease duct as described in NFPA 96.
   c. Rated for continuous operation at 500 °F and intermittent operation at 2000 °F.
   d. All components of the grease duct system shall be provided by the manufacturer to ensure the system meets the requirements of the listing including duct supports, guides, fittings, cleanouts, and expansion joints required to install the duct.

3. Grease duct shall conform to requirements of ASTM E119, and shall be listed by the following agencies with the associated listed reports:

   a. UL 1978 (File MH8251) – Grease Ducts for Restaurant Cooking Appliances.
   b. UL 2221 (File R15388) – Standard for Tests of Fire Resistive Grease Duct Enclosure Assemblies.

4. The wall shall be constructed of stainless steel, 0.035-inch thickness.

5. Construction of Factory Built Grease Duct:

   a. Pipe joints shall be held together by means of formed vee bands and sealed with P080 Grease Duct Sealant.
   b. Connection to the hood will be made with a round hood collar.
   c. Curb mounted fans will incorporate a fan adapter plate.
   d. All construction and supporting of the kitchen ventilation system will be in accordance with the manufacturer’s installation instructions.
   e. Store grease duct sections inside, or covered adequately to protect from weather or accidental damage.

G. Series Fan-Powered Variable Air Volume Terminal Boxes:

1. Terminal boxes shall be size, type, and capacity indicated on drawings. METALAIRE, TRANE, PRICE, TITUS, or Newport News Public Schools approved equal. Units shall be series fan-powered type as indicated. Units shall be ARI certified. Submit sound level data indicating radiated and discharge NC levels for each terminal unit at design airflows.
2. Units shall be complete with insulated casing, electric air valve, and direct digital controls. The direct digital controls shall be furnished by the Temperature Control Contractor and factory installed by the unit manufacturer.
3. Casing: Provide 22-gauge, acoustically lined, galvanized-steel casing. Lining shall be 1” thick, 1.5-lb. per cubic foot density, foil faced, fibrous glass which meets requirements of NFPA 90A. Provide access panel for access to air valves.

4. Primary Air Valve: Provide cylindrical volume control device with electric actuator. Valve inlet shall be 18 gauge steel cylinder sized to fit standard round flexible ductwork. 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.
5. Fan shall be forward-curved blade, with direct-drive, ECM motor, and disconnect switch.
6. Provide 1" fiberglass media filter with filter frame in plenum intake or ducted inlet as indicated.
7. Electric Reheat Coil: The coil shall factory provided and mounted on the discharge outlet. The coils have a resistance open-type heater with a disc-type automatic reset thermal primary safety device. Heater element material is nickel-chromium. Provide heaters with the following options:

    a. Mercury Contactor: An electric heater contact for use with direct digital control or analog electronic controls.
    b. Airflow Switch: An air pressure device designed to disable the heater when the unit fan is off.
    c. Line Fuse: A safety fuse located in the electric heater's line of power to prevent power surge damage to the electric heater. A line fuse shall be provided for the fan motor to prevent power surge damage to the motor.
    d. Disconnect Switch: A factory provided disconnect switch with an interlocking door on the heater control panel.

8. Units shall have removable access panel or access door for service access.
9. Units shall be installed with strict attention paid to manufacturer's recommended length of straight inlet duct.
10. Units shall be installed with internally lined supply ductwork for the first 10 feet of ductwork or to the first branch connection, whichever occurs first.
11. Automatic Controls: Provide factory-installed automatic (direct digital) controls provided by the control vendor. The control vendor shall furnish and variable volume terminal unit manufacturer shall install Direct Digital Controller. Controller shall provide the sequence of operation specified. Controller shall provide the required signals to achieve pressure independent operation throughout the specified volume range of the unit. Variable volume terminal unit manufacturer shall examine terminal unit locations indicated on drawings and shall locate controllers on most accessible side of unit. All costs associated with factory mounting of vendor's controls shall be included in this Section.

2.8 VIBRATION ISOLATION

A. Vibration Isolators:

1. Mechanical equipment indicated below shall be isolated from the structure by resilient vibration and noise isolations. Equipment to be isolated includes, but is not limited to, the following: Packaged Rooftop Units (RAHU).

    a. Vibration Isolation Rail System:

1) Curb mounted rooftop equipment shall be mounted on vibration isolation rails that fit over the roof curb and under the isolated equipment. Curb mounted isolation rails shall be Type CMAB as manufactured by MASON INDUSTRIES, INC. or approved equal.
2) The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal.
3) Aluminum members shall house powder coated springs selected for 0.75" minimum deflection. Travel to solid shall be 1.5" minimum. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds. Manufacturer's self-adhering closed cell sponge gasketing shall be used both above and below the base and a flexible EPDM duct like connection shall seal the outside perimeter. Foam or other sliding or shear seals are unacceptable in lieu of the EPDM duct-like closure.

2. Spring Isolators:

a. Variable Volume Terminal Box Units shall be suspended with vibration spring isolators Type 30N as manufactured by MASON INDUSTRIES, INC. or approved equal.
b. Hangers shall consist of rigid steel frames containing minimum 1-1/4" thick neoprene elements at the top and a steel spring seated in a steel washer reinforced neoprene cup on the bottom. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability, the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

B. Sound Isolation:

1. RAHU Acoustical Systems: Provide acoustical material inside the roof curb as shown on the drawings. Acoustical material shall be furnished by the isolation curb manufacturer, and consist of the following:

a. Provide 2 layers of moisture resistant 5/8" gypsum board on top of 3/8" x 1-3/4" foam pads. Foam pads shall be mounted on 2" aluminum channel that extends the width of the curb rail. The aluminum channel shall be installed above the spring isolator in order to attenuate acoustical vibrations translated through the roof curb.
b. Provide 2" thickness "ROXUL" model AFB acoustic batt insulation with 2.8 lbs./sf density on top of the gypsum board.

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. AHU Supply and Exhaust Fans
   b. RAHU Supply and Exhaust Fans
   c. ERU Supply and Exhaust Fans
   d. Chilled And Hot Water Pumps

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 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 macros 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 shall 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 shall disconnect all input power from the drive and all internally mounted options.

6. 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 shall 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.

7. 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

8. 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

9. 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.

10. 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.

11. EMI / RFI filters. All VFD's shall include EMI/RFI filters.
All VFD's through 75HP at 480 V shall be protected from input and output power mis-wiring.

12. 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.

13. 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.

14. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current.

15. 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.

16. 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, AMERICAN ION, ACTIVE AIR SOLUTIONS, 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, Model GPS-IBAR (AHUs, RAHUs, and ERU-1), 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.
   h. Equipment Requirements:

      1) Electrode Specifications (Bi-polar Ionization):

a) 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.

b) Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.

2) Air Handler Mounted Units:

a) 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.

5. 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.

6. 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.

7. 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.

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 does 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 his 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. Refrigerant piping shall be tested with dry nitrogen and trace of refrigerant at test pressures recommended by equipment manufacturer. After system has been proven tight under test pressure, it shall be evacuated to a pressure 2.5 mm Hg absolute. The refrigerant compressor shall not be used for evacuating the system. Vacuum shall be checked by use of a mercury manometer.

E. Coupled pumps shall be field aligned in accordance with 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.

F. Test all gas piping at 50 psig with oil-free compressed air for 2 hours with no loss in pressure.

3.2 DUCTWORK LEAKAGE TESTING

A. Test all medium pressure supply duct systems to determine the leakage in the systems. The leakage testing shall be performed in accordance with the requirements of SMACNA - ADLTM in presence of Owner or Owner’s Representative.

B. Coordinate test opening size requirements with the test equipment.

C. Coordinate scheduling of tests and all preparations for tests with the Engineer and Owner. The Contractor’s air balancing Contractor and Owner shall witness all leak tests.

D. All medium pressure supply air ductwork shall be leak tested at 3.0" w.c. Allowable leakage shall be in accordance with SMACNA HVAC Air Duct Leakage Test Manual.

E. The air balancing Contractor shall review the test results and provide recommendations for repair and/or modification to any systems which do not meet the allowable leakage rate criteria. Once repairs and/or modifications are complete, the Contractor shall repeat the leakage testing. This process shall continue until the system meets or exceeds the allowable leakage rate criteria. Additional testing shall be performed at the Contractor's expense.

F. Leakage testing shall be performed prior to above ceiling Punch List, insulation of the ductwork and installation of the finished ceilings.

G. Forward all test results to the Engineer for review. Provide copy of all tests to Owner upon completion.

3.3 WATER TREATMENT

A. Provide one year's supply of recommended chemicals for all systems.

B. Prior to commencement of water treatment, including initial flushing of hydronic loop piping, submit qualifications of the water treatment specialist to the Engineer for review and approval. Include in the submittal a detailed schedule of the flushing and final water treatment procedure. 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 and determine the required chemical treatment mixtures and how they shall 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.

C. Prior to filling the chilled and hot 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.

D. The contractor shall retain the services of a water filtration specialist to remove suspended solids and silt from the piping system that passes through the system strainers. The specialist shall provide a temporary portable device to perform continuous filtration and backwash cycles of the chilled and hot water systems. The filter system shall removal suspended solids down to 0.45-micron nominal. The contractor shall continue to filter the hydronic system through the duration of construction. Provide "Waltz Hydronic Filtration Rental Filter System" or approved equal.

E. 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.

F. 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.

G. 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.

H. 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.

I. 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)

J. 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. Submit report to Owner and include any recommendations for adjustment.

K. 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

FORM I-1 REPORT OF BOILER INSTALLATION

in accordance with provisions of the *National Board Inspection Code*

INSTALLATION: ☐ New ☐ Reinstalled ☐ Second Hand Date ____/____/____

INSTALLER	OWNER-USER	OBJECT LOCATION
Name	Name	Name
Street	Street, PO Box, RR	Street
City, State, ZIP	City, State, ZIP	City, State, ZIP

Jurisdiction No.	National Board No.	Manufacturer		Mfg. Serial No.	Year Built	Boiler Type	Boiler Use
Fuel	Method of Firing	Btu/kW input	Btu/kW output	Operating PSI	ASME Code Designator(s) ☐A ☐S ☐U ☐HLW ☐M ☐E ☐H ☐Other		
Stamped MAWP	Heating Surface, Sq. Ft.	Cast Iron	Manhole	Specific On-Site Location, i.e., Utility Room			
Pressure Relief Valve Size	Pressure Relief Valve Set Pressure	Pressure Relief Valve Capacity ☐Btu/hr ☐Lb/hr	Manufacturer	Low-Water Fuel Cutoff Mfg. _____ No.			
1. _____	1. _____	1. _____	1. _____	Probe Type _____			
2. _____	2. _____	2. _____	2. _____	Flow Switch _____			
3. _____	3. _____	3. _____	3. _____	Float & Chamber _____			
4. _____	4. _____	4. _____	4. _____	Other (Specify) _____			

PRESSURE/ALTITUDE GAGE:	EXPANSION TANK:	VENTILATION AND COMBUSTION AIR
Dial Graduation _____	ASME Constructed ☐Yes ☐No	Unobstructed Opening (sq. in.) _____
Valve/Cock Size _____ MAWP _____	Other _____	Power Ventilator Fan (CFM) _____
Pipe Connection Size _____	MAWP _____	
Siphon or Equivalent Device ☐Yes ☐No	No. Gallons _____	

WATER LEVEL INDICATORS:	FEED WATER SUPPLY:
Number of Gage Glasses _____	Number of Feeding Means _____
Number of Remote Indicators _____	Pipe Size _____
Size of Connection Piping _____	Stop Valve Size _____ MAWP _____
	Check Valve Size _____ MAWP _____

STOP VALVES:	EXTERNAL PIPING ASME CODE:	FUEL TRAIN:
Number of Valves _____	☐Yes ☐No	☐CSD-1 ☐NFPA-85
Valve Size _____	☐Other _____	☐Other _____

BOTTOM BLOWDOWN CONNECTIONS:	POTABLE WATER HEATER UNIQUE REQUIREMENTS ☐Yes ☐No
Number of Valves _____	Inlet Stop Valve Size _____ MAWP _____
Valve Size _____ MAWP _____	Outlet Stop Valve Size _____ MAWP _____
Piping Run Full Size ☐Yes ☐No	Drain Valve Size _____
	Thermometer ☐Yes

Manufacturer's Certification Attached: ☐Yes ☐No	Clearance from walls and floors:
Does boiler replace existing one: ☐Yes ☐No	Side _____ Bottom _____ Top _____

Additional recommendations and remarks by installer:

	I HEREBY CERTIFY THAT THE INSTALLATION COMPLIES WITH NBIC, Part 1
Installer Name (PRINT) _____ Registration # _____	Installer Signature _____

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 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.

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.

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. 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.

11. Air Handling unit is defined as any equipment that consists of a fan and coil.

12. Temperatures for each heat exchanger device at maximum capacity, including the following:

    a. Entering and Leaving water temperature.
    b. Entering and Leaving air temperature.

13. Nameplate data of each piece of HVAC equipment installed.
14. GPM of each pump and corresponding suction and discharge pressure.
15. 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.
16. Amp rating and operating amps of each pump. For pump motors requiring three-phase power, record amps of each individual phase.
17. Differential pressure and corresponding GPM across each flow measuring device, including automatic flow control devices.
18. Final percent setting after adjustment of each balancing valve where applicable.
19. 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, or JOHNS MANVILLE 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. 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.

C. 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 ACOUSTIC DUCT LINER

A. Fiberglass duct liner shall not be used.

2.5 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.

2.6 CALCIUM SILICATE PIPE INSULATION INSERTS

A. Calcium silicate meeting ASTM C533, Type I; rigid molded pipe; asbestos-free JOHNS MANVILLE Thermo-12/Gold, or approved equal.

B. Thermal conductivity of 0.45 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.

2.7 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.

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 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:	2" thickness.
Hot Water Heating Water: (In mechanical room)	1" thickness for pipe sizes up to 1-1/2" and 2" thickness for pipe sizes over 1-1/2".
Condensate Drain Above Floor:	1/2" thickness

Cold Water:	1/2" thickness for pipe sizes up to 1-1/4" and 1" thickness for pipe sizes over 1-1/2".
Domestic Hot and Tempered Water and Hot Water Recirculating:	1” thickness for pipe sizes up to 1-1/4” and 1-1/2” thickness for pipe sizes over 1-1/4”.
Refrigerant Suction Piping:	1" thickness flexible unicellular for pipe sizes up to 1-1/2" and 1-1/2" thickness for pipe sizes over 1-1/2".
Chemical Feed:	1/2" thickness (glass fiber, except flexible unicellular for chilled water system)

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.

D. Fittings and valves on refrigerant suction piping shall be insulated with cut sections of flexible unicellular insulation of thickness equal to adjoining pipe insulation.

E. All flexible unicellular and glass fiber piping insulation exposed to the weather shall be provided with aluminum 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. Insulate all hot and chilled water piping above the roof line and outdoors, including inside of outdoor air-handling units. Apply over heat-trace tape.

I. 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

J. Hangers and supports for condenser 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.
2. Exposed: Ductwork which is permanently in view, typically found in mechanical, storage, electrical, or other unfinished space.

B. Schedule:

Concealed Supply, Return Ductwork Externally Insulated: (inside the conditioned space)	2" thickness blanket
Exposed Supply, Return, Relief and Outside Air Ductwork Externally Insulated: (inside the conditioned space)	1-1/2" thickness rigid board
Exposed Supply, Return, Relief and Outside Air Ductwork Externally Insulated: (in all mechanical rooms and mechanical mezzanines)	2"thickness rigid board
Exposed Exhaust Ductwork off of energy recovery units:	1-1/2” thickness rigid board
Plenums:	2" thickness
Transfer Ducts:	Not required
Exhaust Ducts:	Not Required

C. Insulate necks and tops of all supply air diffusers, registers and grilles.

D. Blanket-type insulation shall be stapled and taped in accordance with manufacturer’s instructions.

E. 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.

F. Tape all edges of insulation to ensure that no insulation is exposed.

3.4 COLD EQUIPMENT

A. Schedule:

Chilled Water 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

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 which must be opened periodically for maintenance.

3.5 HOT VESSELS

A. Schedule:

Heat Exchangers:	1-1/2" thickness, rigid fiberglass
Hot Water Pumps:	2" thickness, flexible unicellular
Hot Water System Chemical Feeder:	1/2" thickness, flexible unicellular
Hot Water Expansion Tanks, and Air 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".

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
2. Domestic water heating

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. TABs report
   iv. HVAC Water quality test report
   v. Pre-functional Checklists completed by the installing Foreman.
   vi. O&M Manuals with warranties
   vii. Training class agenda and schedule

b. Commissioning Report: The Commissioning Agent shall assemble the final Commissioning Report comprised of completed pre-functional 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. Direct digital control graphic screen shots of all equipment are submitted showing unit is operating within design parameters.
4. Demonstrate through trend data successful operation of the HVAC systems for a period of not less than 2 weeks.
5. 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. 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
BOOKER T. WASHINGTON MIDDLE SCHOOL

Project # 21-156

THOMPSON
Consulting Engineers
Mechanical and Electrical Engineering
22 Enterprise Parkway, Suite 200, Hampton, VA 23666

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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

Newport News Public Schools
12571 Patrick Henry Drive
Newport News, VA 23602

Architect

TO BE DETERMINED

Mechanical Engineer

Kevin Allen
Thompson Consulting Engineers
22 Enterprise Parkway
Hampton, VA 23666
(757) 599-4415

General Contractor

Mechanical Contractor

Controls Contractor

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 Booker T. Washington Middle School. Where possible, the controls contractor may re-use existing compatible controllers to interface with the Tridium Niagara N4 platform. All new and existing equipment controllers shall be integrated into the Tridium Niagara N4 system architecture for Booker T. Washington 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 Booker T. Washington 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 for integration of existing controllers not replaced with the new Tridium Niagara controls platform.

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 Booker T. Washington 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 setup 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 Booker T. Washington 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, Air Handling Units, DOAS Units, Variable Air Volume Terminal Units, the central plant heating, cooling, and 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 panels 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 BOOKER T. WASHINGTON 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

Addn and Renov. to Booker T. Washington M.S.
Newport News, Virginia

Architect: RRMM Architects

Engineer: Matthew J. Thompson

Mechanical: Tidewater Mechanical

PRCC04032

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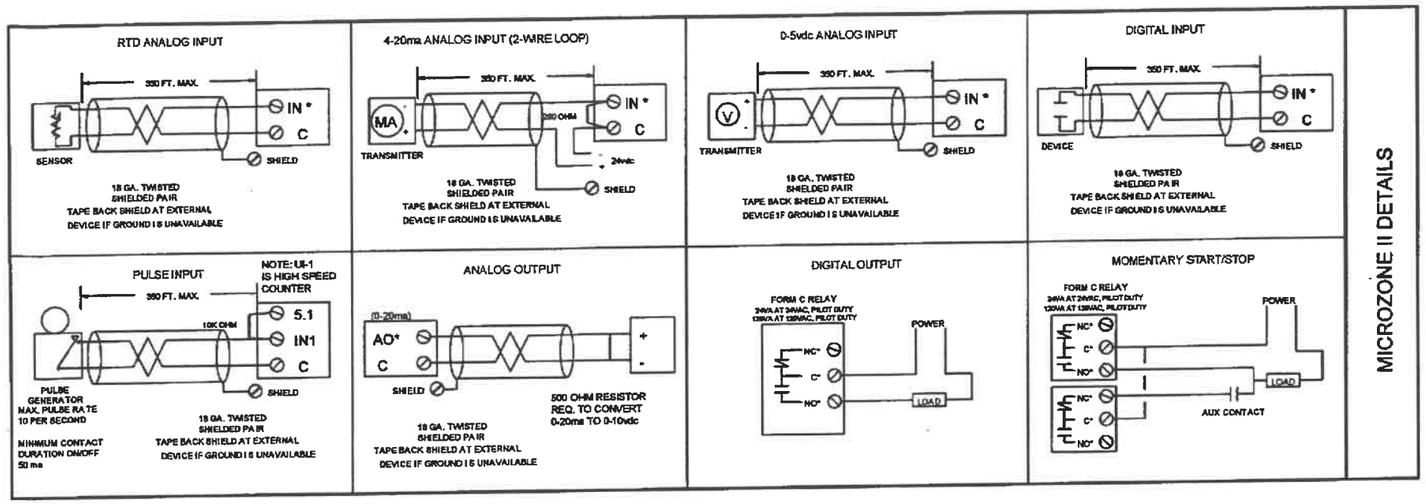
NETWORK 8000 WIRING SPECIFICATION & DETAILS

WIRING DETAILS



LON Bus Wiring and Installation Guide Lines

General Guidelines: FTT-10

Devices are polarity insensitive.

- LON must include the appropriate End of Line Terminator.

Bus cable should be Category 4 or better 0.65mm (22 AWG) unshielded models

- If shielded cable is used, the shield wire must be run continuously throughout the segment and be grounded through a 470K ohm, 1/4 watt resistor at one end only (any point in a Free Topology segment).

A maximum of 64 FTT transceivers can exist on a single wiring segment. This total includes any commissioning tool and the LNC.

Repeaters must be used if total wiring length or segments on a device are exceeded. 127 devices total on a subnet.

Use plenum cable where required.

Bus Topology Guidelines

The maximum length of the lon without the use of repeaters must not exceed 1400m (4593 feet) when using the recommended 0.62mm (22 AWG) cabling.

Bus topology can only have two end.

LON-TERM2 termination devices must be installed on each end.

ASD Bus Wiring and Installation Guide Lines

GENERAL WIRING

- All wiring must be done in accordance with the control wiring diagrams and in compliance with the National Electric Code, state and local codes and ordinances, and the job specification.
- All wiring installation practices must conform to guidelines listed in the Network 8000 Hardware Installation Practices Manual (F-23061-1).
- Wiring between devices should be installed using a continuous run of wire, avoid splices.
- High voltage cables (over 30vac or 30vdc) shall not be run in the same conduit as point wiring (AI, DI, AO) and LAN line wiring. A separate conduit shall be installed.
- High voltage cables (over 30vac or 30vdc) shall not be routed through the left side of the GCM/LCM/MZII sub-base.
- All equipment requiring a line power source shall be on a dedicated circuit.
- All DDC panels require an equipment ground. The ground wire should be connected to the ground bus bar in the power panel that supplies power to the DDC panel. Metal raceway (conduit, wiremold, etc.) shall not be used as the grounding source.

AI, DI, AO POINT WIRING

- All external devices shall be connected to the controllers using 18AWG stranded color coded twisted shielded pair cable. This cables capacitance between any one conductor and other conductors connected to the shield should be no greater than 60pF per foot with a maximum distance as listed.
- For non-plenum cable use Belden 8760 or equivalent. Where plenum rated cable is required use Belden 82760 or equivalent.
- Each connected device requires a separate signal and return conductor.

DO POINT WIRING

- All external devices shall be connected using a minimum of 18AWG cable.
- Digital Output wiring cannot be intermixed with power wiring and other types of Class 2 wiring.
- When powering multiple Class 2 devices from the same transformer polarity must be observed (24H connected to 24H and 24G connected to 24G) and the transformer frame must be grounded.

LAN WIRING

- The maximum length of the lan without the use of repeaters must not exceed 4000' when using 24 AWG or larger cable.
- The use of multi-pair twisted shielded cable is not acceptable for lan communication wiring.
- The cable must be twisted shielded cable with the cable shield be connected to SHLD or GND terminals of each controller.
- The cable must be one continuous run with no tee, spur, or star connections.
- Polarity must be observed with + connecting to + and - connecting to - .
- End of Line (EOL) resistors are required at each line segment end.

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Revisions

#	Change:	Date:

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

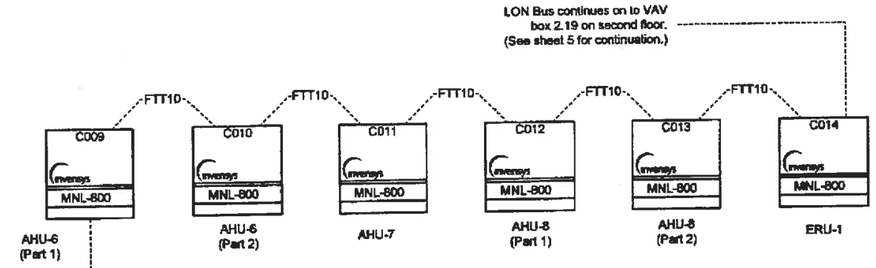
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

Installation Notes

JOB NUMBER PRCC04032

FILE NAME WIRINGNOTES.vwd

SHEET NO. 1 OF 39



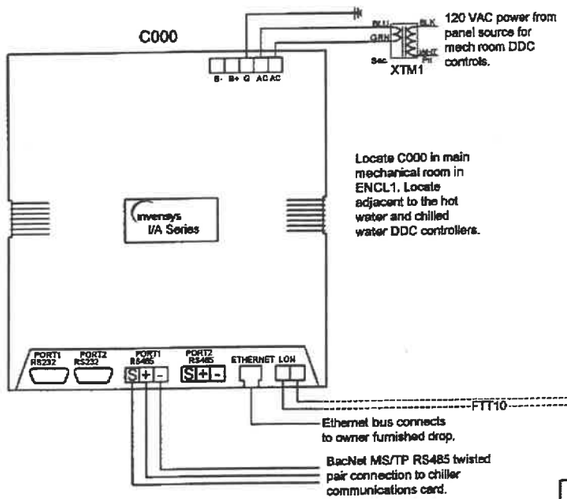
C009 thru C014 are hot water and chilled water system controller located in mechanical room on lower level.

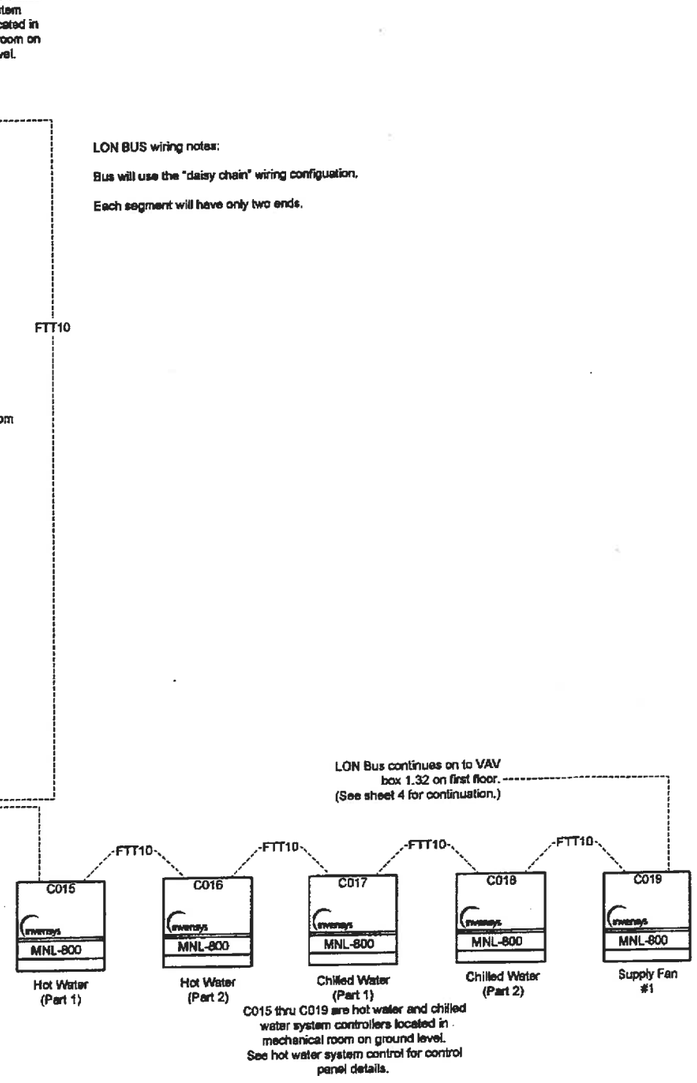
LON BUS wiring notes:

Bus will use the "daisy chain" wiring configuation.

Each segment will have only two ends.

FTT10





C015 thru C019 are hot water and chilled water system controllers located in mechanical room on ground level. See hot water system control for control panel details.

Architecture Device	Qty	Part Number	Description	Vendor
PS1	1	KEL-DCP-250-H	120vac/24vdc Power Supply 250	Single Sourced Solutions
RPTR	1	ECH-FTR-120	HARDING INSTRUMENTS LONWORKS R	SINGLE SOURCED SOLUTIONS
TERM1-4	5	LON-TERM2	LON TERMINATION, DOUBLE, FOR F	INVENSYS BLDG SYSTEMS

Host/PC/Communication System Device	Qty	Part Number	Description	Vendor
LapTop	2	Laptop PC	Laptop PC as described on dwg.	Purchased
WPA-LON	2	WPA-LON-2	ECHELON FTT-10 PCMCIA WKPLACE	INVENSYS BLDG SYSTEMS

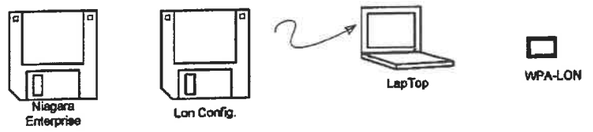
Lon Configuration Software Device	Qty	Part Number	Description	Vendor
MN-TECH-CD	1	MN-TECH-CD	MicroNet Tech Tool & Workplace Tech	Purchased

Niagara Software Device	Qty	Part Number	Description	Vendor
IA-ENT-N	2	IA-ENT-N	Software for Additional Station	INVENSYS BLDG SYSTEMS

UNC Controller Device	Qty	Part Number	Description	Vendor
C000	1	UNC-510-2	NETWORK CONTROLLER 10/100 MBIT	INVENSYS BLDG SYSTEMS
C000_1	1	AE-630	CONTROL CABINET 16W X 24H X	INVENSYS BLDG SYSTEMS
C000_2	1	AE-630-101	CONTROL CABINET SUB-PANEL FOR	INVENSYS BLDG SYSTEMS
ENCL1	1	AE-630	CONTROL CABINET 16W X 24H X	INVENSYS BLDG SYSTEMS
ENCL1_1	1	AE-630-101	CONTROL CABINET SUB-PANEL FOR	INVENSYS BLDG SYSTEMS
XTM1	1	T-201-1	TRANSFORMER 50 VA, 120V-P, 24V	SINGLE SOURCED SOLUTIONS

Laptop specifications

LapTop: Dell Inspiron 8200 Portable Lap Top Computer
CPU, Mobile Pentium 3 Processor,
15.0" UXGA TFT display
Memory, 256 MB, 133M SDRAM
Video Card, 32 MB DDR nVidia GeForce4, 440 Go AGP 4X Graphics
Hard Drive, 60 GB Hard Drive
Floppy Drive, 3.5" 1.44 MB
Operating System, Microsoft Windows XP Professional
Integrated 10/100 Ethernet Network Card
Modem, Internal 56K modem



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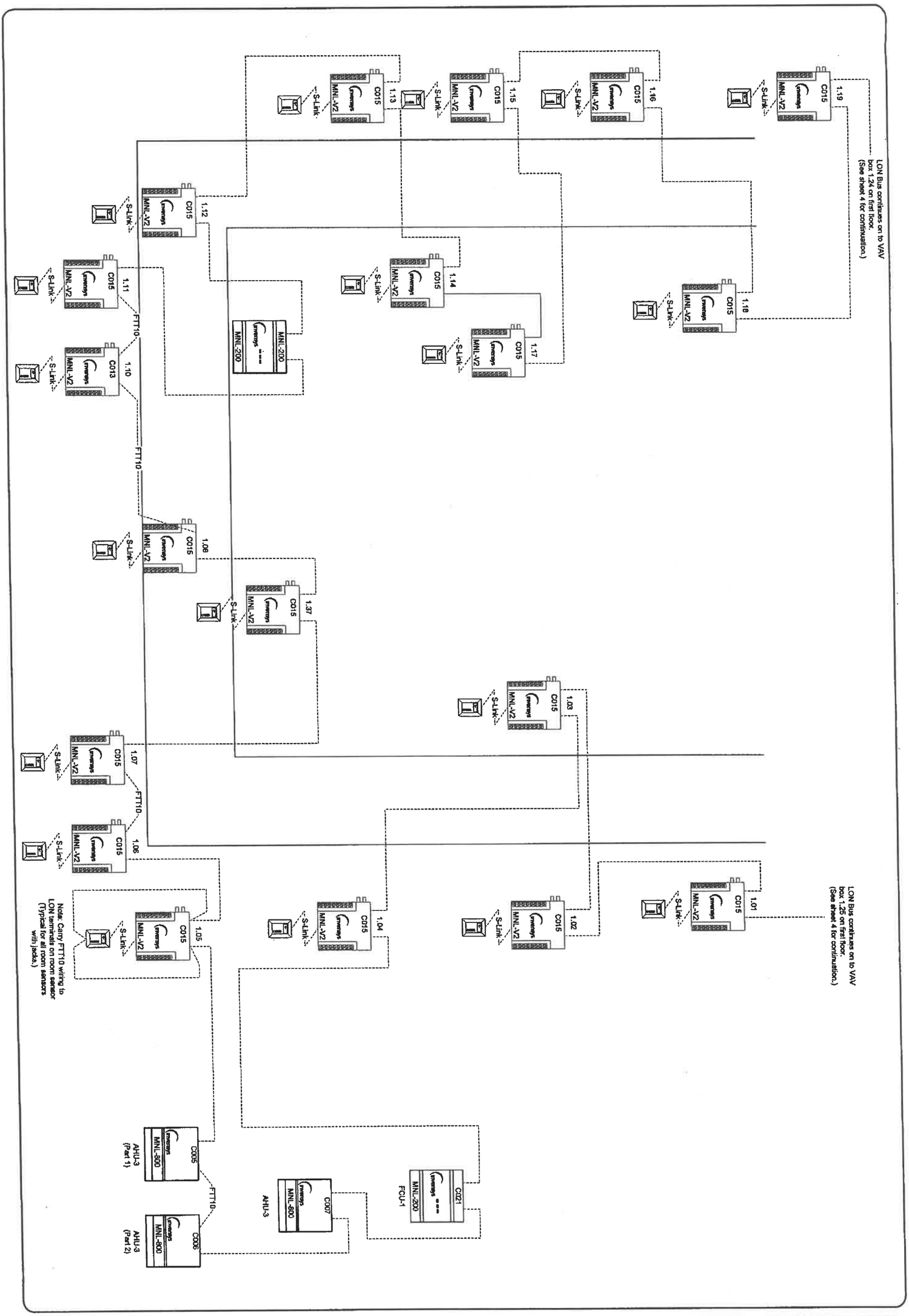
Revisions

#	Change:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia
Boiler Rm DDC Architecture

Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

JOB NUMBER PRCC04032
FILE NAME Architecture.vsd
SHEET NO. 2 OF 39



JOB NUMBER PRCC04032	Addn and Renov. to Booker T. Washington M.S.	Architect:	RRMM Architects
FILE NAME Architecture.vsd	Chesnut Avenue	Engineer:	Matthew J. Thompson
SHEET NO. 3 OF 39	Newport News, Virginia	Contractor:	Tidewater Mechanical
	Architecture (1st Flr Part A)	Designed by:	SBP Date: 3/14/05
		Software by:	Date:
		Checked by:	Date:

Revisions		
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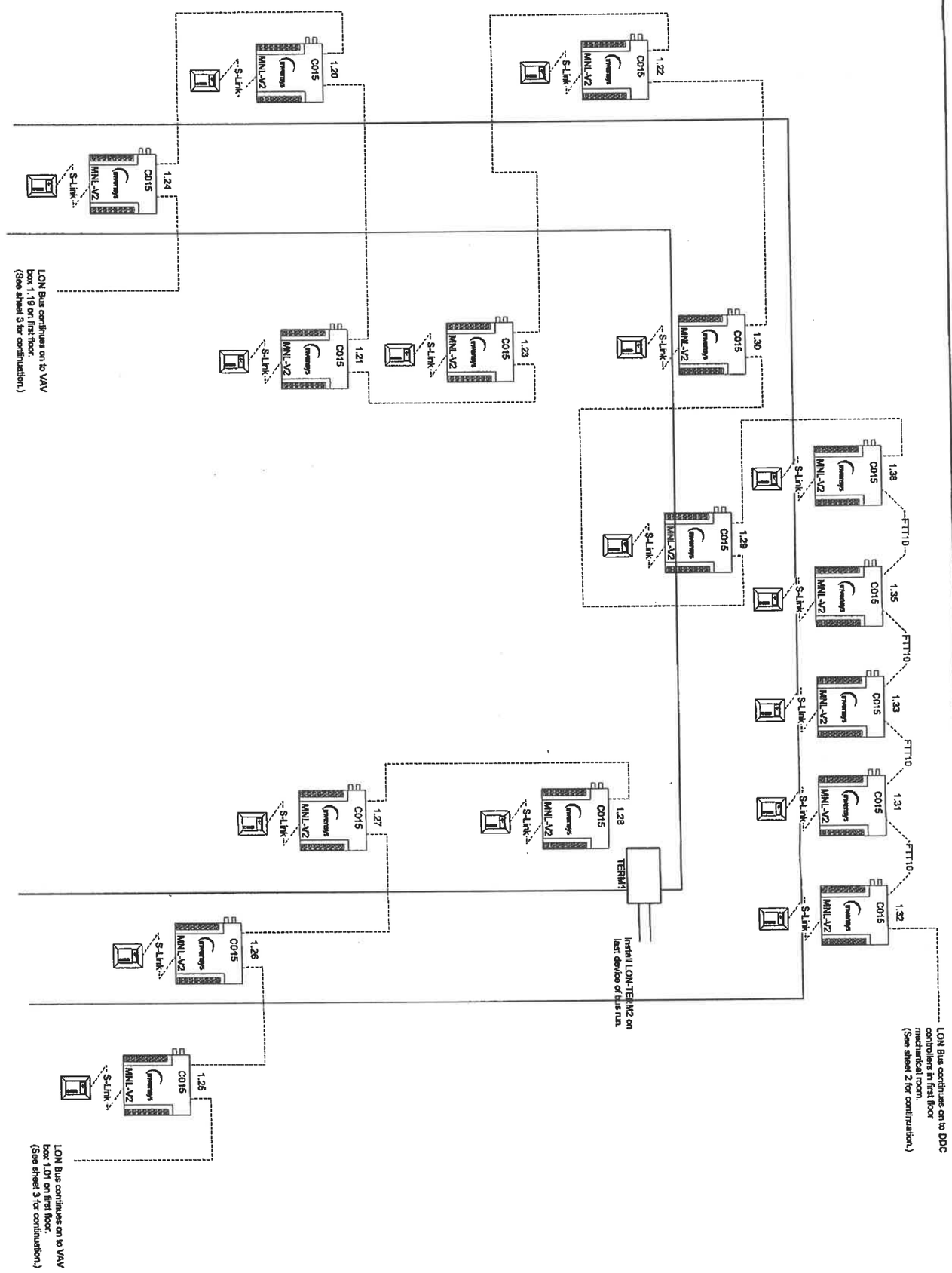

JOB NUMBER PRCC04032	Addn and Renov. to Booker T. Washington M.S.	Architect:	RRMM Architects	
FILE NAME Architecture.vsd	Chesnut Avenue	Engineer:	Matthew J. Thompson	
	Newport News, Virginia	Contractor:	Tidewater Mechanical	
SHEET NO. 4 OF 39	Architecture (1st Flr Part B)	Designed by:	SBP	Date: 3/14/05
		Software by:		Date:
		Checked by:		Date:

Revisions		
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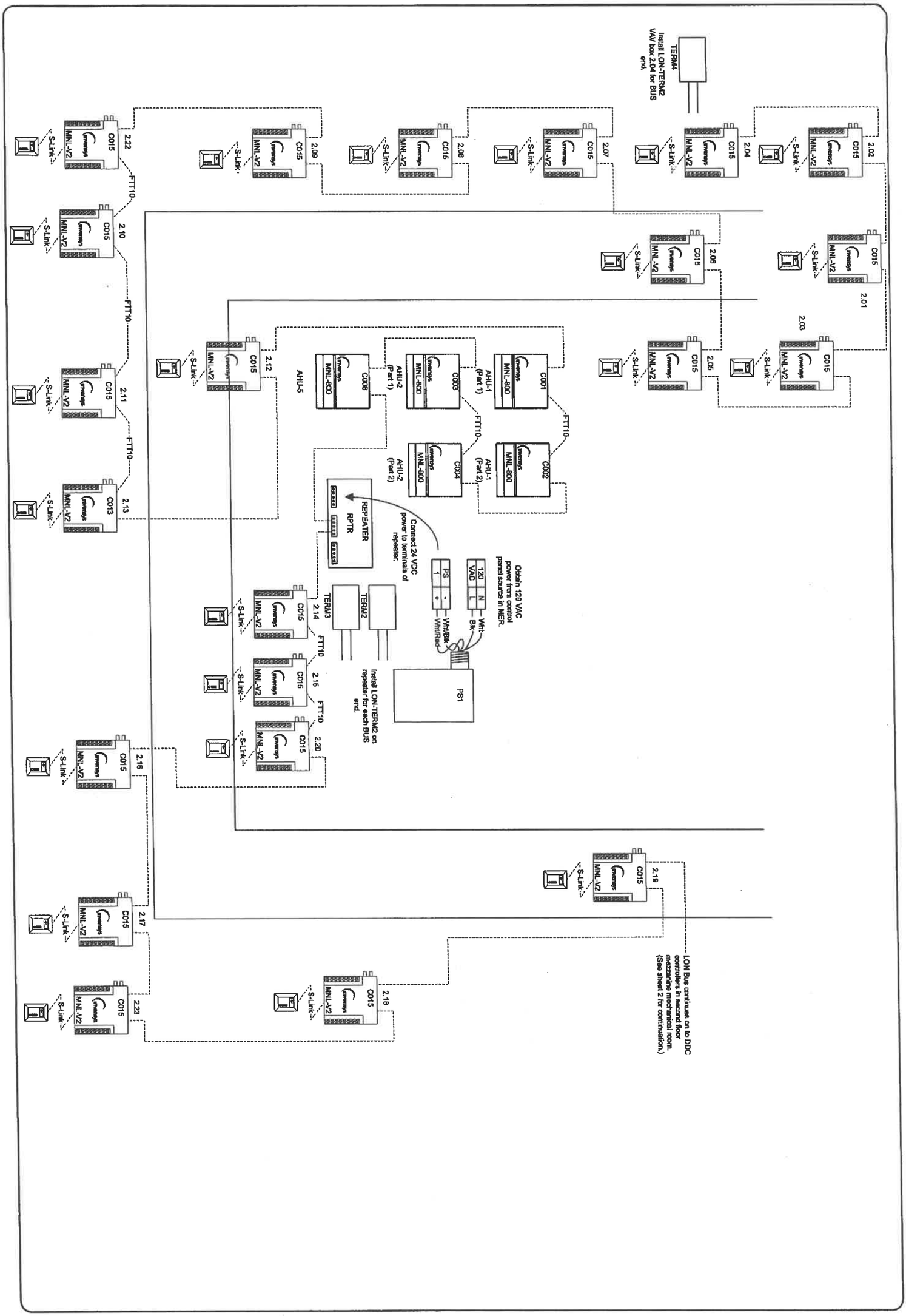

JOB NUMBER PRCC04032	Addn and Renov. to Booker T. Washington M.S.	Architect:	RRMM Architects	Revisions	
FILE NAME Architecture.vwd	Chesnut Avenue	Engineer:	Matthew J. Thompson	# Change:	Date:
SHEET NO. 5 OF 39	Newport News, Virginia	Contractor:	Tidewater Mechanical		
	Architecture (2nd Floor)	Designed by:	SBP Date: 3/14/05		
		Software by:	Date:		
		Checked by:	Date:		

Dominion Energy Management Inc.

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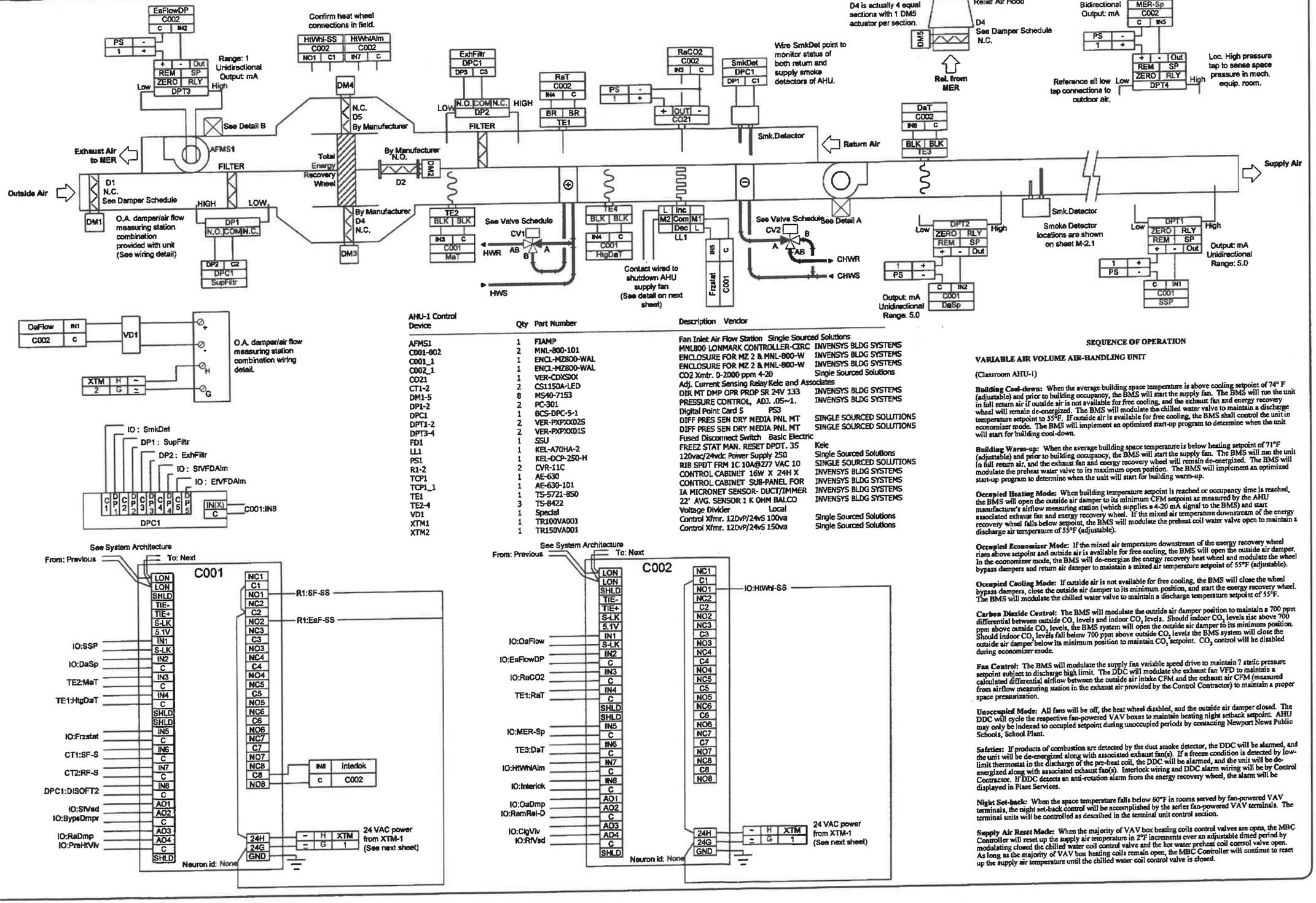

AHU-1 Control Device	Qty	Part Number	Description	Vendor
AFMS1	1	FIAMP	Fan Inlet Air Flow Station	Single Sourced Solutions
C001-002	2	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS BLDG SYSTEMS
C001_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
C002_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
CO21	1	VER-CDXSXX	CO2 Xmtr. 0-2000 ppm 4-20	Single Sourced Solutions
CT1-2	2	CS1150A-LED	Adj. Current Sensing Relay Kele and Associates	
DM1-5	8	MS40-7153	DIR MT DMP OPR PROP SR 24V 133	INVENSYS BLDG SYSTEMS
DP1-2	2	PC-301	PRESSURE CONTROL, ADJ. .05~1.	INVENSYS BLDG SYSTEMS
DPC1	1	BCS-DPC-5-1	Digital Point Card 5 PS3	
DPT1-2	2	VER-PXPXX02S	DIFF PRES SEN DRY MEDIA PNL MT	SINGLE SOURCED SOLUTIONS
DPT3-4	2	VER-PXPXX01S	DIFF PRES SEN DRY MEDIA PNL MT	SINGLE SOURCED SOLUTIONS
FD1	1	SSU	Fused Disconnect Switch Basic Electric	
LL1	1	KEL-A70HA-2	FREEZ STAT MAN. RESET DPDT. 35	Kele
PS1	1	KEL-DCP-250-H	120vac/24vdc Power Supply 250	Single Sourced Solutions
R1-2	2	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
TCP1	1	AE-630	CONTROL CABINET 16W X 24H X	INVENSYS BLDG SYSTEMS
TCP1_1	1	AE-630-101	CONTROL CABINET SUB-PANEL FOR	INVENSYS BLDG SYSTEMS
TE1	1	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER	INVENSYS BLDG SYSTEMS
TE2-4	3	TS-8422	22' AVG. SENSOR 1 K OHM BALCO	INVENSYS BLDG SYSTEMS
VD1	1	Special	Voltage Divider Local	
XTM1	1	TR100VA001	Control Xfmr. 120vP/24vS 100va	Single Sourced Solutions
XTM2	1	TR150VA001	Control Xfmr. 120vP/24vS 150va	Single Sourced Solutions

SEQUENCE OF OPERATION

VARIABLE AIR VOLUME AIR-HANDLING UNIT

(Classroom AHU-1)

Building Cool-down: When the average building space temperature is above cooling setpoint of 74° F (adjustable) and prior to building occupancy, the BMS will start the supply fan. The BMS will run the unit in full return air if outside air is not available for free cooling, and the exhaust fan and energy recovery wheel will remain de-energized. The BMS will modulate the chilled water valve to maintain a discharge temperature setpoint to 55°F. If outside air is available for free cooling, the BMS shall control the unit in economizer mode. The BMS will implement an optimized start-up program to determine when the unit will start for building cool-down.

Building Warm-up: When the average building space temperature is below heating setpoint of 71°F (adjustable) and prior to building occupancy, the BMS will start the supply fan. The BMS will run the unit in full return air, and the exhaust fan and energy recovery wheel will remain de-energized. The BMS will modulate the preheat water valve to its maximum open position. The BMS will implement an optimized start-up program to determine when the unit will start for building warm-up.

Occupied Heating Mode: When building temperature setpoint is reached or occupancy time is reached, the BMS will open the outside air damper to its minimum CFM setpoint as measured by the AHU manufacturer's airflow measuring station (which supplies a 4-20 mA signal to the BMS) and start associated exhaust fan and energy recovery wheel. If the mixed air temperature downstream of the energy recovery wheel falls below setpoint, the BMS will modulate the preheat coil water valve open to maintain a discharge air temperature of 55°F (adjustable).

Occupied Economizer Mode: If the mixed air temperature downstream of the energy recovery wheel rises above setpoint and outside air is available for free cooling, the BMS will open the outside air damper. In the economizer mode, the BMS will de-energize the energy recovery heat wheel and modulate the wheel bypass dampers and return air damper to maintain a mixed air temperature setpoint of 55°F (adjustable).

Occupied Cooling Mode: If outside air is not available for free cooling, the BMS will close the wheel bypass dampers, close the outside air damper to its minimum position, and start the energy recovery wheel. The BMS will modulate the chilled water valve to maintain a discharge temperature setpoint of 55°F.

Carbon Dioxide Control: The BMS will modulate the outside air damper position to maintain a 700 ppm differential between outside CO_2 levels and indoor CO_2 levels. Should indoor CO_2 levels rise above 700 ppm above outside CO_2 levels, the BMS system will open the outside air damper to its minimum position. Should indoor CO_2 levels fall below 700 ppm above outside CO_2 levels the BMS system will close the outside air damper below its minimum position to maintain CO_2 setpoint. CO_2 control will be disabled during economizer mode.

Fan Control: The BMS will modulate the supply fan variable speed drive to maintain ? static pressure setpoint subject to discharge high limit. The DDC will modulate the exhaust fan VFD to maintain a calculated differential airflow between the outside air intake CFM and the exhaust air CFM (measured from airflow measuring station in the exhaust air provided by the Control Contractor) to maintain a proper space pressurization.

Unoccupied Mode: All fans will be off, the heat wheel disabled, and the outside air damper closed. The DDC will cycle the respective fan-powered VAV boxes to maintain heating night setback setpoint. AHU may only be indexed to occupied setpoint during unoccupied periods by contacting Newport News Public Schools, School Plant.

Safeties: If products of combustion are detected by the duct smoke detector, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). If a freeze condition is detected by low-limit thermostat in the discharge of the pre-heat coil, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). Interlock wiring and DDC alarm wiring will be by Control Contractor. If DDC detects an anti-rotation alarm from the energy recovery wheel, the alarm will be displayed in Plant Services.

Night Set-back: When the space temperature falls below 60°F in rooms served by fan-powered VAV terminals, the night set-back control will be accomplished by the series fan-powered VAV terminals. The terminal units will be controlled as described in the terminal unit control section.

Supply Air Reset Mode: When the majority of VAV box heating coils control valves are open, the MBC Controller will reset up the supply air temperature in 2°F increments over an adjustable timed period by modulating closed the chilled water coil control valve and the hot water preheat coil control valve open. As long as the majority of VAV box heating coils remain open, the MBC Controller will continue to reset up the supply air temperature until the chilled water coil control valve is closed.

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Authorized Invensys Representitive

Revisions

#	Change:	Date:

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

AHU-1 Control (Part 1)

JOB NUMBER PRCC040320
FILE NAME AHU 1.vsd
SHEET NO. 6 OF 39

Note: 1 panel PNL will be provided for panel mounted items for AHU-1 and AHU-2.

Locate panel in mechanical equipment room 214.

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Architect:	RRMM Architects
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Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

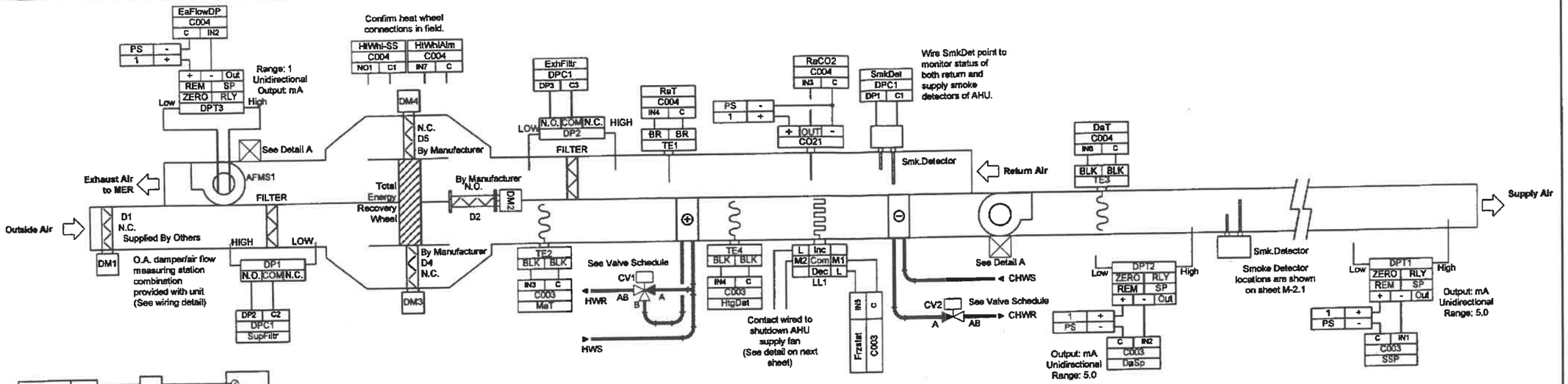
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

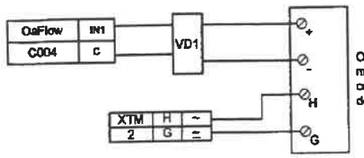
AHU-1 Control (Part 2)

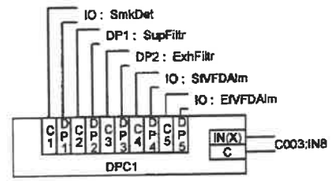
JOB NUMBER PRCC04032

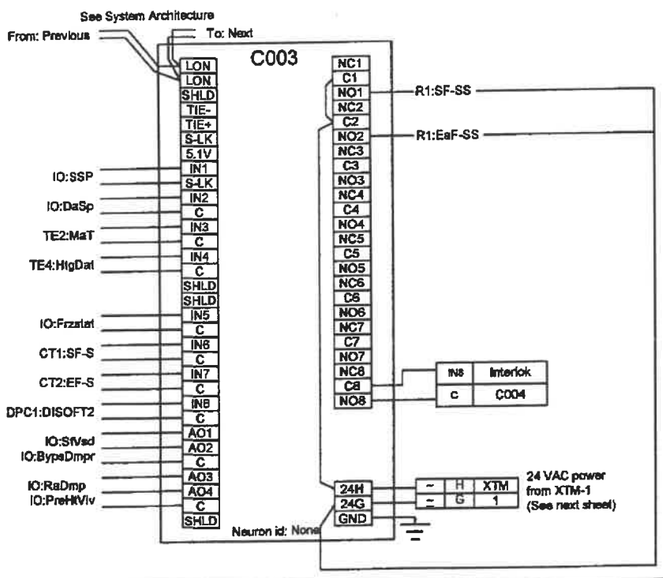
FILE NAME AHU 1.vsd

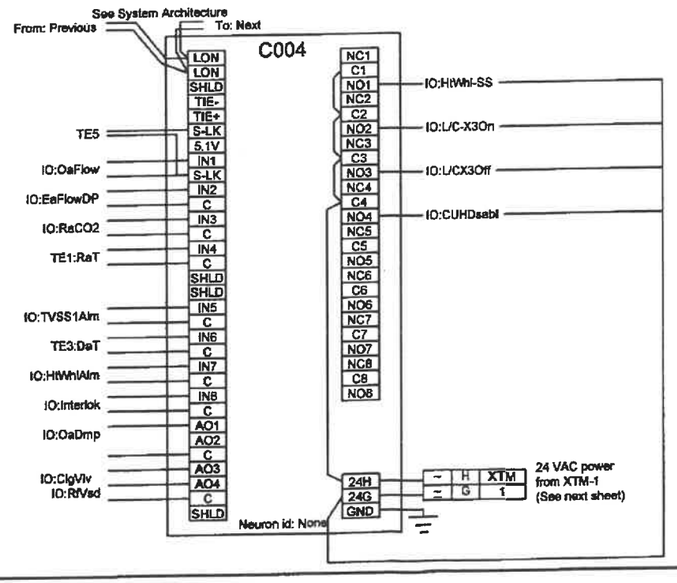
SHEET NO. 7 OF 39











AHU-2 Control Device	Qty	Part Number	Description	Vendor
AFMS1	1	FIAMP	Fan Inlet Air Flow Station	Single Sourced Solutions
CO3-004	2	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS BLDG SYSTEMS
CO3_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
C004_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
CO21	1	VER-CDXSXX	CO2 Xmtr. 0-2000 ppm 4-20	Single Sourced Solutions
CT1-2	2	CS1150A-LED	Adj. Current Sensing Relay	Kele and Associates
DM1-4	4	MS40-7153	DIR MT DMP OPR PROP SR 24V 133	INVENSYS BLDG SYSTEMS
DP1-2	2	PC-301	PRESSURE CONTROL, ADJ. .05~1.	INVENSYS BLDG SYSTEMS
DPC1	1	BCS-DPC-5-1	Digital Point Card 5	PS3
DPT1-2	2	VER-PXPX002S	DIFF PRES SEN DRY MEDIA PNL MT	SINGLE SOURCED SOLUTIONS
DPT3	1	VER-PXPX001S	DIFF PRES SEN DRY MEDIA PNL MT	SINGLE SOURCED SOLUTIONS
LL1	1	KEL-A70HA-2	FREEZ STAT MAN. RESET DPDT. 35	Kele
PS2	1	KEL-DCP-250-H	120vac/24vdc Power Supply 250	Single Sourced Solutions
R1-2	2	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
TE1	1	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER	INVENSYS BLDG SYSTEMS
TE2-4	3	TS-8422	22' AVG. SENSOR 1 K OHM BALCO	INVENSYS BLDG SYSTEMS
VD1	1	Special	Voltage Divider	Local
XTM3	1	TR50VA001	Control Xfmr. 120vP/24vS 50va	Single Sourced Solutions
XTM4	1	TR100VA001	Control Xfmr. 120vP/24vS 100va	Single Sourced Solutions

SEQUENCE OF OPERATION

VARIABLE AIR VOLUME AIR-HANDLING UNIT

(Classroom AHU-2)

Building Cool-down: When the average building space temperature is above cooling setpoint of 74° F (adjustable) and prior to building occupancy, the BMS will start the supply fan. The BMS will run the unit in full return air if outside air is not available for free cooling, and the exhaust fan and energy recovery wheel will remain de-energized. The BMS will modulate the chilled water valve to maintain a discharge temperature setpoint to 55°F. If outside air is available for free cooling, the BMS shall control the unit in economizer mode. The BMS will implement an optimized start-up program to determine when the unit will start for building cool-down.

Building Warm-up: When the average building space temperature is below heating setpoint of 71°F (adjustable) and prior to building occupancy, the BMS will start the supply fan. The BMS will run the unit in full return air, and the exhaust fan and energy recovery wheel will remain de-energized. The BMS will modulate the preheat water valve to its maximum open position. The BMS will implement an optimized start-up program to determine when the unit will start for building warm-up.

Occupied Heating Mode: When building temperature setpoint is reached or occupancy time is reached, the BMS will open the outside air damper to its minimum CFM setpoint as measured by the AHU manufacturer's airflow measuring station (which supplies a 4-20 mA signal to the BMS) and start associated exhaust fan and energy recovery wheel. If the mixed air temperature downstream of the energy recovery wheel falls below setpoint, the BMS will modulate the preheat coil water valve open to maintain a discharge air temperature of 55°F (adjustable).

Occupied Economizer Mode: If the mixed air temperature downstream of the energy recovery wheel rises above setpoint and outside air is available for free cooling, the BMS will open the outside air damper. In the economizer mode, the BMS will de-energize the energy recovery heat wheel and modulate the wheel bypass dampers and return air damper to maintain a mixed air temperature setpoint of 55°F (adjustable).

Occupied Cooling Mode: If outside air is not available for free cooling, the BMS will close the wheel bypass dampers, close the outside air damper to its minimum position, and start the energy recovery wheel. The BMS will modulate the chilled water valve to maintain a discharge temperature setpoint of 55°F.

Carbon Dioxide Control: The BMS will modulate the outside air damper position to maintain a 700 ppm differential between outside CO_2 levels and indoor CO_2 levels. Should indoor CO_2 levels rise above 700 ppm above outside CO_2 levels, the BMS system will open the outside air damper to its minimum position. Should indoor CO_2 levels fall below 700 ppm above outside CO_2 levels the BMS system will close the outside air damper below its minimum position to maintain CO_2 setpoint. CO_2 control will be disabled during economizer mode.

Fan Control: The BMS will modulate the supply fan variable speed drive to maintain ? static pressure setpoint subject to discharge high limit. The DDC will modulate the exhaust fan VFD to maintain a calculated differential airflow between the outside air intake CFM and the exhaust air CFM (measured from airflow measuring station in the exhaust air provided by the Control Contractor) to maintain a proper space pressurization.

Unoccupied Mode: All fans will be off, the heat wheel disabled, and the outside air damper closed. The DDC will cycle the respective fan-powered VAV boxes to maintain heating night setback setpoint. AHU may only be indexed to occupied setpoint during unoccupied periods by contacting Newport News Public Schools, School Plant.

Safeties: If products of combustion are detected by the duct smoke detector, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). If a freeze condition is detected by low-limit thermostat in the discharge of the pre-heat coil, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). Interlock wiring and DDC alarm wiring will be by Control Contractor. If DDC detects an anti-rotation alarm from the energy recovery wheel, the alarm will be displayed in Plant Services.

Night Set-back: When the space temperature falls below 60°F in rooms served by fan-powered VAV terminals, the night set-back control will be accomplished by the series fan-powered VAV terminals. The terminal units will be controlled as described in the terminal unit control section.

Supply Air Reset Mode: When the majority of VAV box heating coils control valves are open, the MBC Controller will reset up the supply air temperature in 2°F increments over an adjustable timed period by modulating closed the chilled water coil control valve and the hot water preheat coil control valve open. As long as the majority of VAV box heating coils remain open, the MBC Controller will continue to reset up the supply air temperature until the chilled water coil control valve is closed.

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#	Change:	Date:
	Revisions	

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

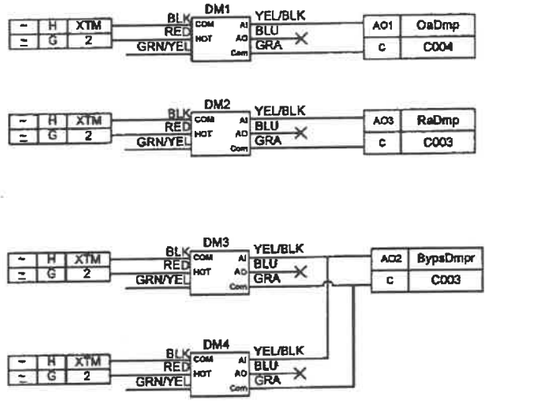
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

AHU-2 Control (Part 1)

JOB NUMBER PRCC04032

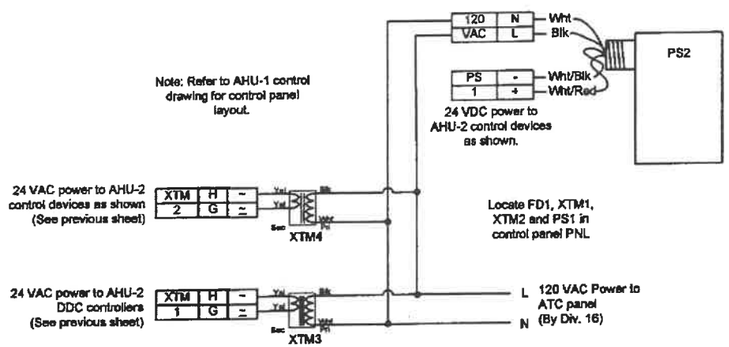
FILE NAME AHU 2.vsd

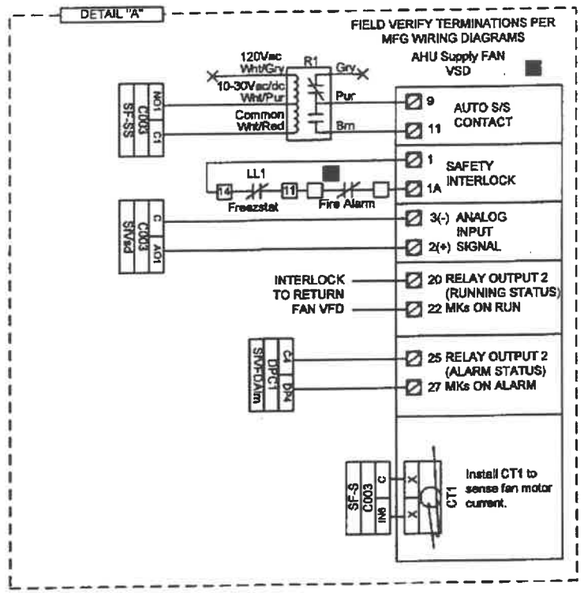
SHEET NO. 8 OF 39

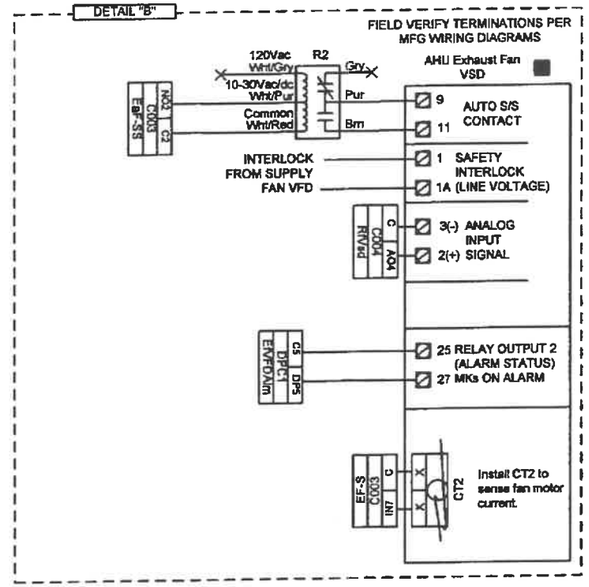


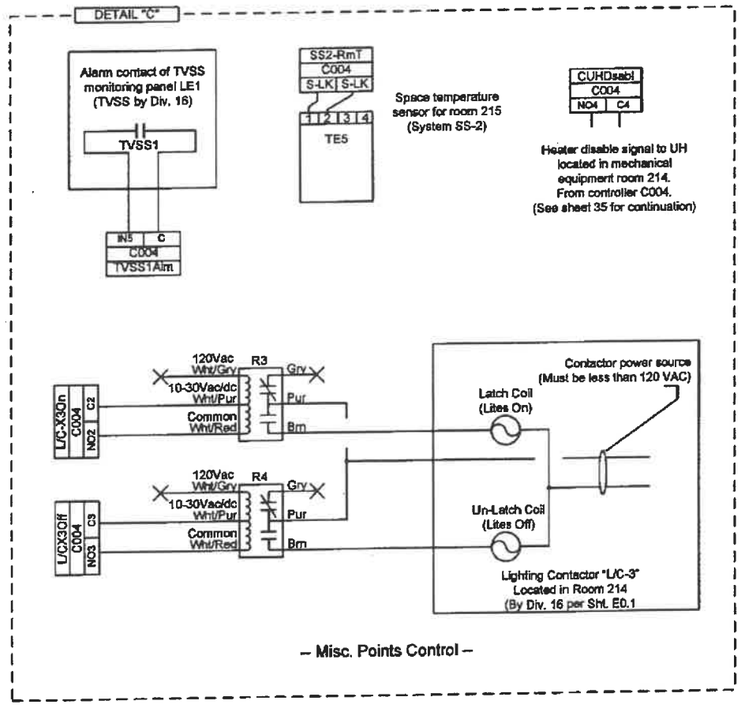
500 ohm resistor incorporated into CV1 actuator. External resistor not required.

500 ohm resistor incorporated into CV1 actuator. External resistor not required.









Misc Points Device	Qty	Part Number	Description	Vendor
R3-4	2	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
TE5	1	MN-S1	1A MICRONET S-LINK SENSOR	INVENSYS BLDG SYSTEMS

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Revisions

#	Change:	Date:

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

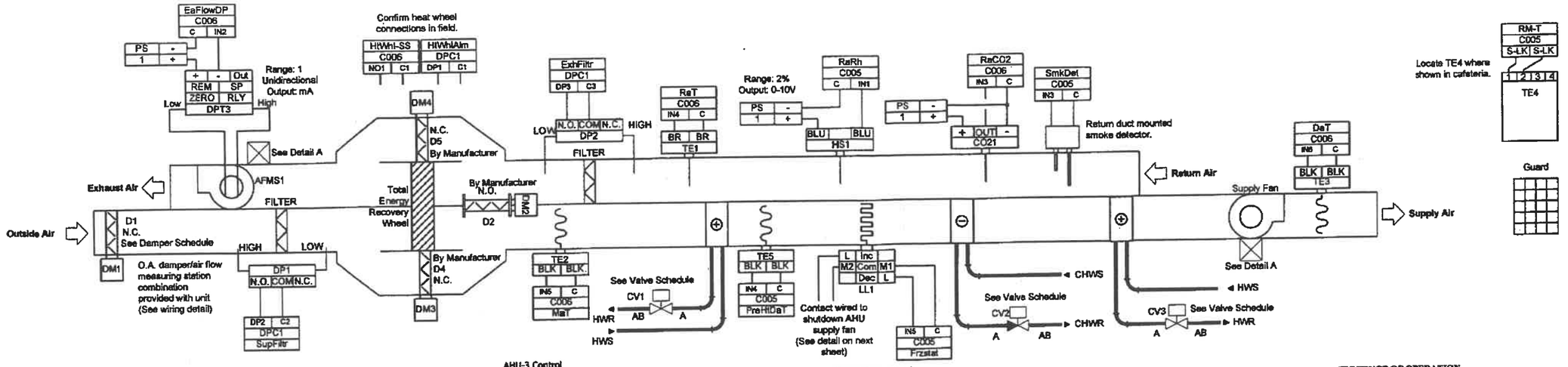
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

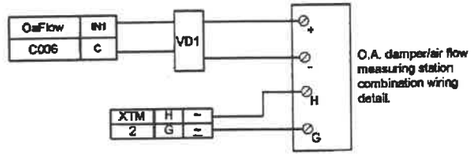
AHU-2 Control (Part 2)

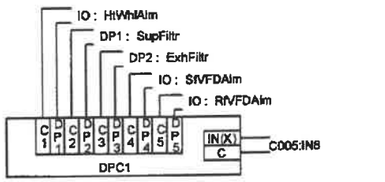
JOB NUMBER PRCC04032

FILE NAME AHU 2.vwd

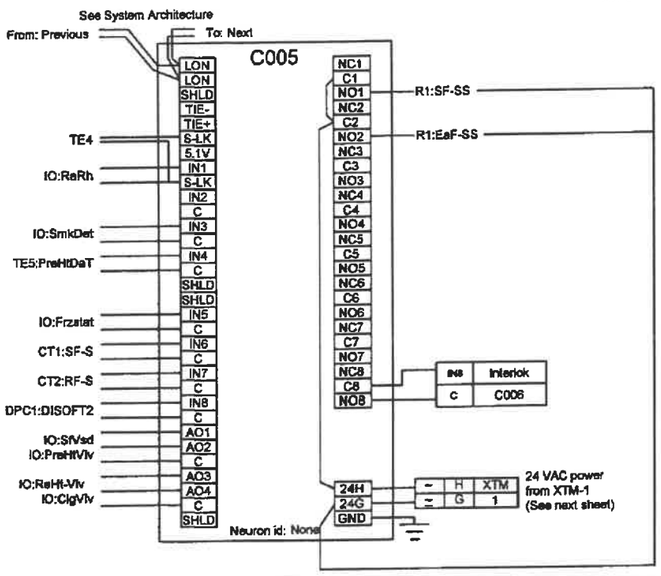
SHEET NO. 9 OF 39

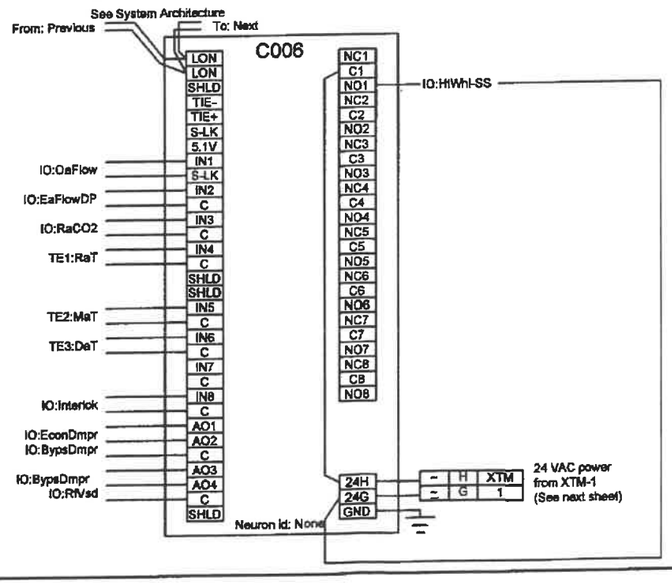






AHU-3 Control Device	Qty	Part Number	Description	Vendor
AFMS1	1	FIAMP	Fan Inlet Air Flow Station	Single Sourced Solutions
C005-006	2	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS BLDG SYSTEMS
C005_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
C006_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
CO21	1	VER-CDXSXX	CO2 Xmtr. 0-2000 ppm 4-20	Single Sourced Solutions
CT1-2	2	CS1150A-LED	Adj. Current Sensing Relay Kele and Associates	
DM1-4	4	MS40-7153	DIR MT DMP OPR PROP SR 24V 133	INVENSYS BLDG SYSTEMS
DP1-2	2	PC-301	PRESSURE CONTROL, ADJ. .05~1.	INVENSYS BLDG SYSTEMS
DPC1	1	BCS-DPC-5-1	Digital Point Card 5 PS3	
DPT3	1	VER-PXPXX015	DIFF PRES SEN DRY MEDIA PNL MT	SINGLE SOURCED SOLUTIONS
FD1	1	SSU	Fused Disconnect Switch Basic Electric	
Guard	1	AT-1104	TSTAT GUARD, CAST FOR SINGLE S	INVENSYS BLDG SYSTEMS
HS1	1	VER-HD2XMSX	DUCT MTD HUM SEN 2% 4-20MA OUT	SINGLE SOURCED SOLUTIONS
LL1	1	KEL-A70HA-2	FREEZ STAT MAN. RESET DPDT. 35	Kele
PS1	1	KEL-DCP-250-H	120vac/24vdc Power Supply 250	Single Sourced Solutions
R1-2	2	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
TCP1	1	AE-630	CONTROL CABINET 16W X 24H X	INVENSYS BLDG SYSTEMS
TCP1_1	1	AE-630-101	CONTROL CABINET SUB-PANEL FOR	INVENSYS BLDG SYSTEMS
TE1	1	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER	INVENSYS BLDG SYSTEMS
TE2-3,5	3	TS-8422	22' AVG. SENSOR 1 K OHM BALCO	INVENSYS BLDG SYSTEMS
TE4	1	MN-S1	IA MICRONET S-LINK SENSOR	INVENSYS BLDG SYSTEMS
VD1	1	Special	Voltage Divider Local	
XTM1	1	TR50VA001	Control Xfmr. 120vP/24vS 50va	Single Sourced Solutions
XTM2	1	TR100VA001	Control Xfmr. 120vP/24vS 100va	Single Sourced Solutions





SEQUENCE OF OPERATION

CONSTANT VOLUME AIR-HANDLING UNIT (CAFETERIA RAHU-3)

Building Cool-down: When the average space temperature is above cooling setpoint of 74°F (adjustable) and prior to building occupancy, the BMS will start the supply fan. The BMS will run the unit in full return air if outside air is not available for free cooling, and the exhaust fan and energy recovery wheel will remain de-energized. The BMS will modulate the chilled water valve to maintain a discharge temperature of 55°F. If outside air is available for free cooling, the BMS will control the unit in economizer mode. The BMS will implement an optimized start-up program to determine when the unit will start for building cool-down.

Building Warm-up: When the average building space temperature is below heating setpoint of 71°F (adjustable) and prior to building occupancy, the BMS will start the supply fan. The BMS will run the unit in full return air, and the exhaust fan and energy recovery wheel will remain de-energized. The BMS will modulate the preheat water valve to its maximum open position. The BMS will implement an optimized start-up program to determine when the unit will start for building warm-up.

Occupied Heating Mode: When building temperature setpoint is reached or occupancy time is reached, the BMS will open the outside air damper to its minimum CFM setpoint as measured by the AHU manufacturer's airflow measuring station (which supplies a 4-20 mA signal to the BMS) and start associated exhaust fan and energy recovery wheel. If the mixed air temperature downstream of the energy recovery wheel falls below setpoint, the BMS will modulate the preheat coil water valve open to maintain a discharge air temperature of 55°F (adjustable). If the space temperature falls below setpoint, the BMS will modulate the heating coil water valve open to maintain a space temperature of 70°F (adjustable). Once setpoint is reached and with the heating water valve fully open to the coil, the BMS shall modulate the supply fan variable speed drive to maintain space temperature. Airflow will not fall below 50%. Should airflow reach 50%, and space temperature remain satisfied, the BMS will modulate the heating water valve to maintain space temperature setpoint. On a fall in space temperature below the setpoint, the reverse sequence will occur.

Occupied Economizer Mode: If the mixed air temperature downstream of the energy recovery wheel rises above setpoint and outside air is available for free cooling, the BMS will open the outside air damper. In the economizer mode, the BMS will de-energize the energy recovery heat wheel and modulate the wheel bypass dampers and return air damper to maintain a mixed air temperature setpoint of 55°F (adjustable).

Occupied Cooling Mode: If outside air is not available for free cooling, the BMS will close the wheel bypass dampers, close the outside air damper to its minimum position, and start the energy recovery wheel. The BMS will modulate the chilled water valve to maintain a space temperature setpoint of 72°F (adjustable). Once setpoint is reached and with the chilled water valve fully open to the coil, the BMS will modulate the supply fan variable speed drive to maintain space temperature. Airflow will not fall below 50%. Should airflow reach 50%, and space temperature remain satisfied, the BMS will modulate the chilled water valve to maintain space temperature setpoint. On a rise in space temperature above the setpoint, the reverse sequence will occur.

Carbon Dioxide Control: The BMS will modulate the outside air damper position to maintain a 700 ppm differential between outside CO_2 levels and indoor CO_2 levels. Should indoor CO_2 levels rise above 700 ppm above outside CO_2 levels, the BMS system will open the outside air damper to its minimum position. Should indoor CO_2 levels fall below 700 ppm above outside CO_2 levels the BMS system will close the outside air damper below its minimum position to maintain CO_2 setpoint. CO_2 control will be disabled during economizer mode.

Humidity Control: The BMS will modulate the supply fan variable speed drive to maintain space humidity setpoint of 60% RH (adjustable). Should the space RH rise above setpoint, the BMS will modulate the supply fan speed to a minimum of 50% of total airflow to maintain space humidity setpoint. Once the supply fan speed reaches 50% of total airflow and if space RH is above setpoint, the cooling water valve will be opened 100% for full dehumidification. During full dehumidification, the heating coil will modulate to maintain space temperature. Should space cooling temperature rise above setpoint during the dehumidification sequence, the dehumidification sequence will be disabled.

Unoccupied Mode: All fans will be off, the heat wheel disabled, and the outside air damper closed.

Night Set-back: When the space temperature falls below 60°F (adj.), the DDC will enable the supply fan and fully open the reheat control valve. When the space temperature rises to 65°F (adj.), the DDC will disable the supply fan. The unit will operate with 100% return air until setpoint is reached.

Safeties: If products of combustion are detected by the duct smoke detector, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). If a freeze condition is detected by low-limit thermostat in the discharge of the pre-heat coil, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). Interlock wiring and DDC alarm wiring will be by Control Contractor. If DDC detects an anti-rotation alarm from the energy recovery wheel, the alarm will be displayed in Plant Services.

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Revisions

#	Change:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

AHU-3 Control (Part 1)

JOB NUMBER PRCC04032
FILE NAME AHU 3.vsd
SHEET NO. 10 OF 39

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Revisions

#	Change:	Date:

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

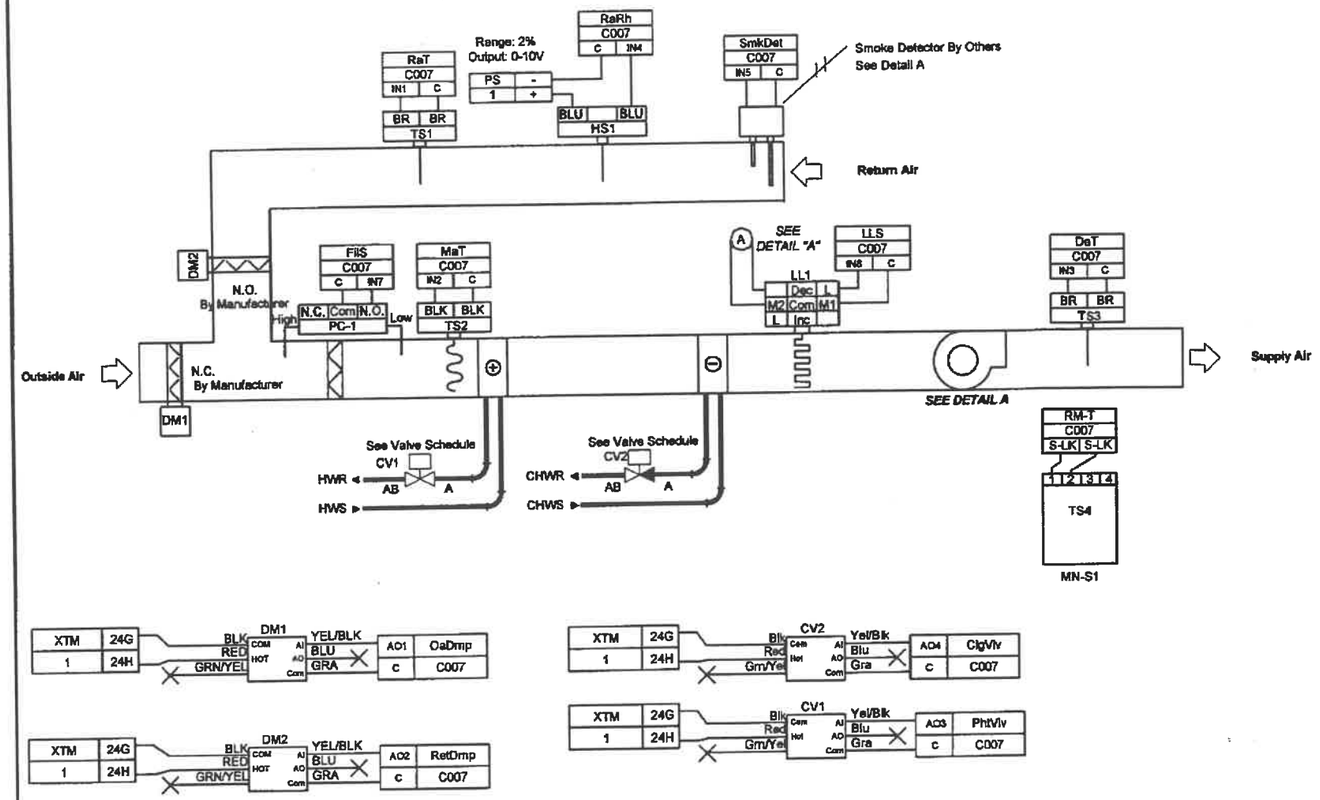
JOB NUMBER PRCC04032

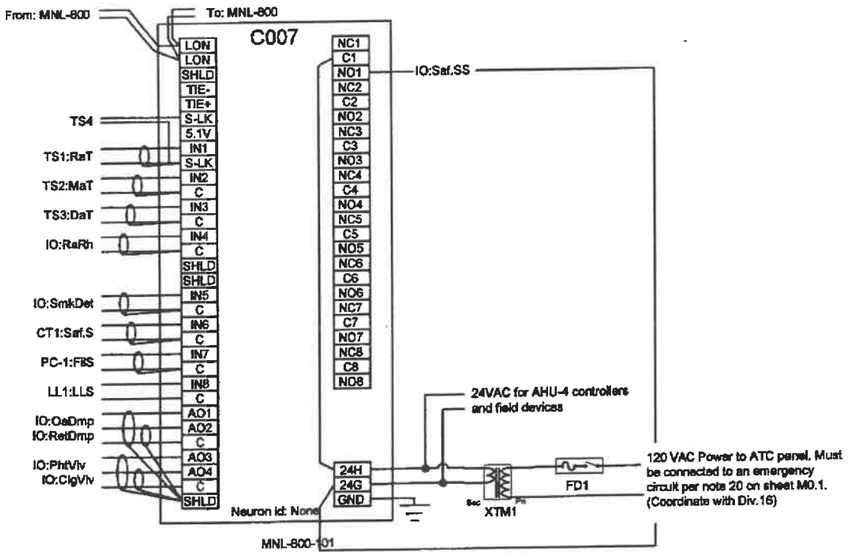
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

FILE NAME AHU 3.vsd

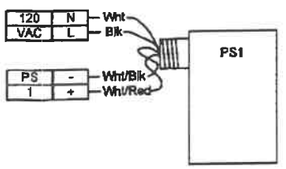
AHU-3 Control (Part 2)

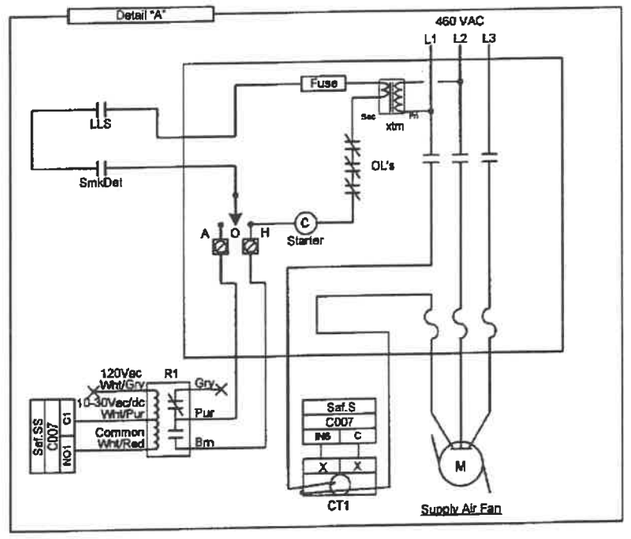
SHEET NO. 11 OF 39





Locate controllers and control equipment with controls for RTU-3 in room A50.





AHU-4 Control Device	Qty	Part Number	Description	Vendor
C007	1	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS BLDG SYSTEMS
C007_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
CT1	1	E112-708	ADJ SETPT; TRIP LED; POWER LED	SINGLE SOURCED SOLUTIONS
DM1-2	2	MS40-7043	DIR MT DMP OPR PROP SR 24V 35	INVENSYS BLDG SYSTEMS
FD1	1	SSU	Fused disconnect switch	Local
HS1	1	VER-HD2XMSX	DUCT MTD HUM SEN 2% 4-20MA OUT	SINGLE SOURCED SOLUTIONS
LL1	1	KEL-A70HA-2	FREEZ STAT MAN. RESET DPDT. 35	Kele
PC-1	1	PC-301	PRESSURE CONTROL, ADJ. .05~1.	INVENSYS BLDG SYSTEMS
PC-1_1	1	DYN-DPS-06	AIR FLOW SENS PROB 6"	SINGLE SOURCED SOLUTIONS
PS1	1	KEL-DCP-250-H	120vac/24vdc Power Supply 250	Single Sourced Solutions
R1	1	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
TS2	1	TS-8405	5' AVG. SENSOR 1 K OHM BALCO	INVENSYS BLDG SYSTEMS
TS1,3	2	TS-5721-850	IA MN SNSR-DUCT/IMMERS	INVENSYS BLDG SYSTEMS
TS4	1	MN-S1	IA MICRONET S-LINK SENSOR	INVENSYS BLDG SYSTEMS
XTM1	1	TR100VA001	Control Xfmr. 120vP/24vS 100va	Single Sourced Solutions

Sequence of Operation

CONSTANT VOLUME AIR-HANDLING UNIT (KITCHEN AHU-4)

Unoccupied Mode: When the building is indexed for unoccupied operation, the DDC will disable the supply fan, close the chilled water control valve, open the heating water control valve, close the outside air and relief air dampers, and open the return air damper.

Night Set-back: When the space temperature falls below 60°F (adj.), the DDC will enable the supply fan and fully open the heating coil (preheat position) control valve. When the space temperature rises to 65°F (adj.) the DDC will disable the supply fan. The unit will operate with 100% return air until setpoint is reached.

Night Set-up: When the space temperature rises to 90°F (adj.) or above, the DDC will enable the supply fan and fully open the chilled water control valve. When the space temperature falls to 85°F (adj.), the DDC will disable the supply fan and close the chilled water control valve. The unit will operate with 100% return air until setpoint is reached.

Warm-up: When the optimal start program calls for warm-up operation, the DDC will enable the supply fan and fully open the heating coil control valve. The unit will operate with 100% return air until setpoint is reached.

Cool-down: When the optimal start program calls for cool-down operation, the DDC will enable the supply fan and fully open the chilled water control valve. The unit will operate with 100% return air until setpoint is reached.

Occupied Mode: When the building is indexed for occupied operation, and the unit is not running on warm-up or cool-down, the DDC will open the outdoor air and relief air dampers, close the return air damper to its minimum outside air position, and enable the supply fan. The actual time for occupied operation will be one hour prior to normal occupancy time to permit an IAQ pre-operation period.

Temperature Control: On a fall in space temperature below setpoint, the DDC will modulate the heating coil control valve fully open. On a rise in space temperature, the DDC will modulate the heating coil control valve closed. On a further rise in the space temperature above setpoint (adj.), the DDC will modulate the chilled water control valve fully open. On a fall in space temperature, the reverse will occur.

Freeze Protection: Should the heating coil leaving air temperature drop to 35°F or below, the low limit thermostat will disable the supply fan, the outside air and relief air dampers will close, the return damper will open, and an alarm generated. The chilled water valve and heating coil valve will fully open to maintain water flow through coil.

Smoke Control: Should products of combustion be detected, the supply fan will be disabled, the outdoor air and relief air dampers will be closed, and an alarm generated.

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Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

Addn and Renov. to Booker T. Washington M.S.
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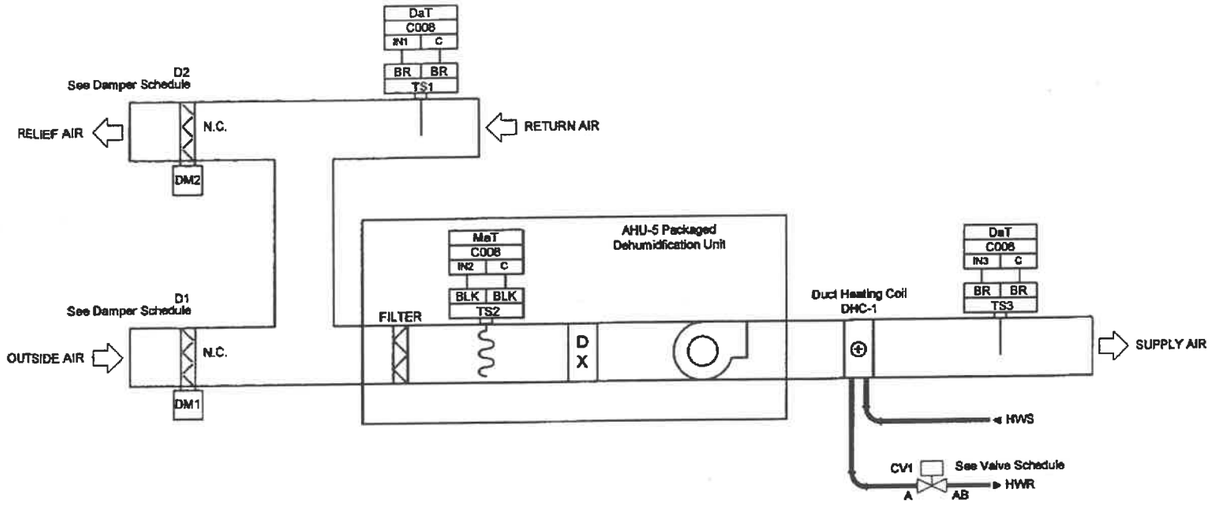
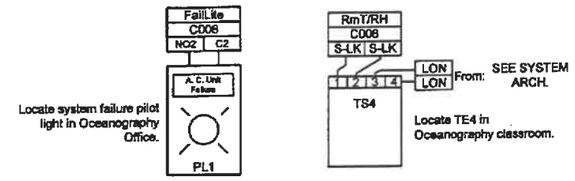
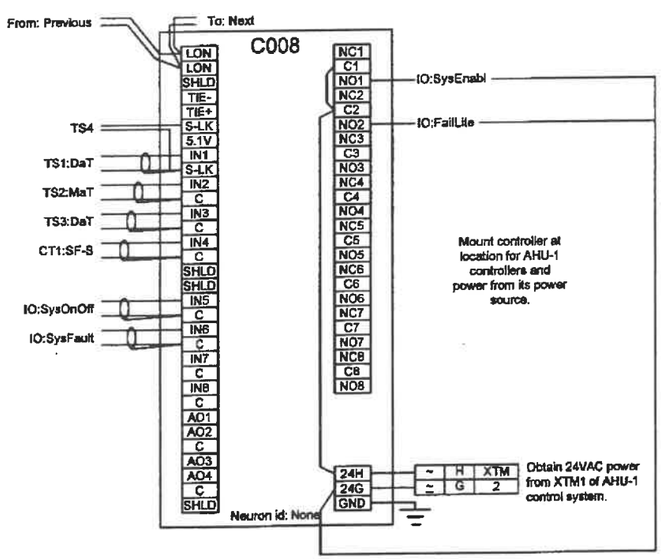
Newport News, Virginia

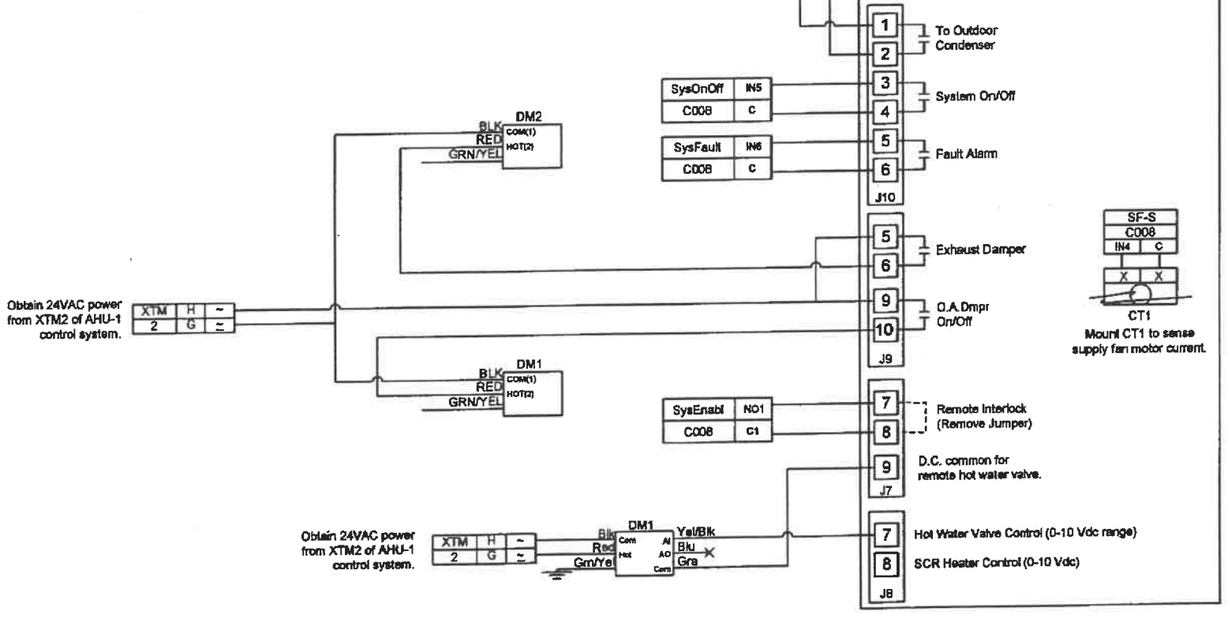
AHU-4 Control

JOB NUMBER PRCC04032
FILE NAME AHU 4.vwd
SHEET NO. 12 OF 39









Air Handling Unit 5 Control Device	Qty	Part Number	Description	Manufacturer
C008	1	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS- AUTOMATION
C008_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS- COMPONENTS
CT1	1	E112-708	ADJ SETPT; TRIP LED; POWER LED	VERIS
DM1-2	2	MA40-7043	DIR MT DMP OPR 2 POS SR 24V 35	INVENSYS- COMPONENTS
DM1	1	MS40-7153	DIR MT DMP OPR PROP SR 24V 133	INVENSYS- COMPONENTS
PL1	1	KEL-L4017	Lamp Socket	Kele and Associates
PL1_1	1	KEL-L4025	Flat Lens, Reg	Kele and Associates
PL1_2	5	KEL-24PSBS	Lamp, 24 VAC/DC	Kele and Associates
PL1_3	1	Nametag	Engraved "A. C. Unit Failure"	Local
TS2	1	TS-8405	5' AVG. SENSOR 1 K OHM BALCO	INVENSYS- COMPONENTS
TS1,3	2	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER	INVENSYS- AUTOMATION
TS4	1	MN-S1HT	IA MICRONET S-LINK HUMIDITY, S	INVENSYS- AUTOMATION

SEQUENCE OF OPERATION

DEHUMIDIFICATION UNIT (OCEANOGRAPHY RAHU-5)

The dehumidification indoor and outdoor condenser unit will be enabled by a contact closure form the DDC controller and will be controlled by the unit manufacturer's self-contained control system. Refer to Section 15800 for details. Control interlock wiring will by this Section. The DDC system will monitor fan status, unit discharge air temperature, return air temperature, mixed air temperature, space temperature, space humidity for monitoring, and alarming. Upon failure or signals outside normal ranges (space temperature or relative humidity), the DDC Controller will alarm to Plant Services and activate a red light located in the Oceanography Office.

Whenever RAHU-5 is energized, the DDC Controller will open the outside air control damper.

Duct Heating Coil: Duct heating coil will be controlled by an analog output of the RAHU control package. On a fall in space temperature below setpoint, the heating water control valve will fully open.

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Revisions

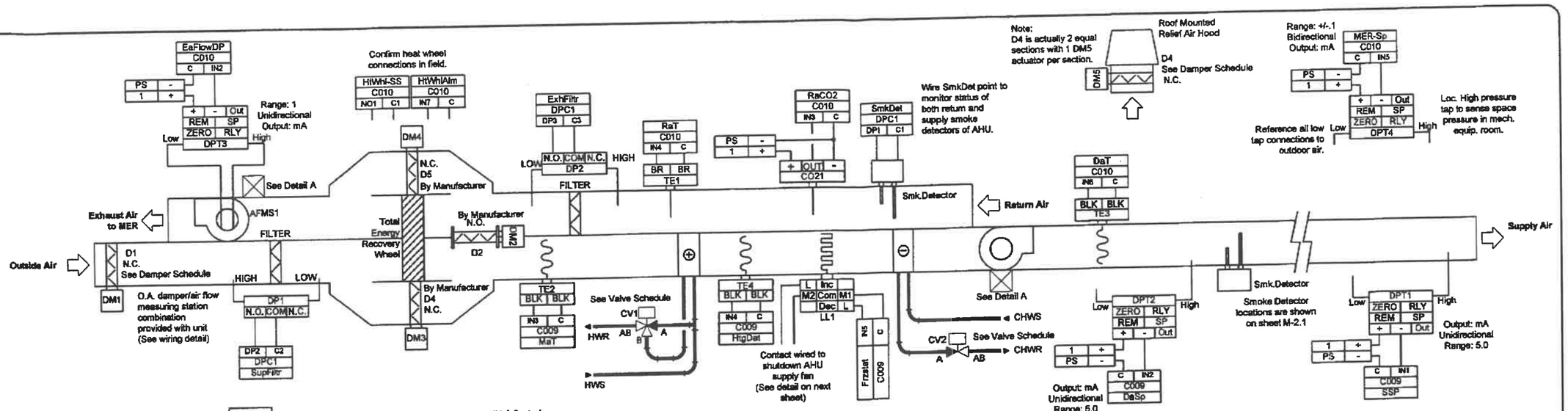
#	Change:	Date:

Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

AHU-5 Control

JOB NUMBER PRCC04032
FILE NAME AHU 5.vwd
SHEET NO. 13 OF 39



AHU-6 Control Device	Qty	Part Number	Description	Vendor
AFMS1	1	FIAMP	Fan Inlet Air Flow Station	Single Sourced Solutions
C009-010	2	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS BLDG SYSTEMS
C009_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
C010_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
CO21	1	VER-CDXSXX	CO2 Xmtr. 0-2000 ppm 4-20	Single Sourced Solutions
CT1-2	2	CS1150A-LED	Adj. Current Sensing Relay	Kele and Associates
DM1-5	6	MS40-7153	DIR MT DMP OPR PROP SR 24V 133	INVENSYS BLDG SYSTEMS
DP1-2	2	PC-301	PRESSURE CONTROL, ADJ. .05~1.	INVENSYS BLDG SYSTEMS
DPC1	1	BCS-DPC-5-1	Digital Point Card 5	PS3
DPT1-2	2	VER-PXPX0025	DIFF PRES SEN DRY MEDIA PNL MT	SINGLE SOURCED SOLUTIONS
DPT3-4	2	VER-PXPX0015	DIFF PRES SEN DRY MEDIA PNL MT	SINGLE SOURCED SOLUTIONS
FD1	1	SSU	Fused Disconnect Switch	Basic Electric
LL1	1	KEL-A70HA-2	FREEZ STAT MAN. RESET DPDT. 35	Kele
PS1	1	KEL-DCP-250-H	120vac/24vdc Power Supply 250	Single Sourced Solutions
R1-2	2	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
TCP1	1	AE-631	CONTROL CABINET 24 W X 32H	INVENSYS BLDG SYSTEMS
TCP1_1	1	AE-631-101	CONTROL CABINET SUB-PANEL FOR	INVENSYS BLDG SYSTEMS
TE1	1	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER	INVENSYS BLDG SYSTEMS
TE2-4	3	TS-8422	22' AVG. SENSOR 1 K OHM BALCO	INVENSYS BLDG SYSTEMS
VD1	1	Special	Voltage Divider	Local
XTM1	1	TR50VA001	Control Xfmr. 120vP/24vS 50va	Single Sourced Solutions
XTM2	1	TR100VA001	Control Xfmr. 120vP/24vS 100va	Single Sourced Solutions

SEQUENCE OF OPERATION

VARIABLE AIR VOLUME AIR-HANDLING UNIT

(Classroom AHU-6)

Building Cool-down: When the average building space temperature is above cooling setpoint of 74° F (adjustable) and prior to building occupancy, the BMS will start the supply fan. The BMS will run the unit in full return air if outside air is not available for free cooling, and the exhaust fan and energy recovery wheel will remain de-energized. The BMS will modulate the chilled water valve to maintain a discharge temperature setpoint to 55°F. If outside air is available for free cooling, the BMS shall control the unit in economizer mode. The BMS will implement an optimized start-up program to determine when the unit will start for building cool-down.

Building Warm-up: When the average building space temperature is below heating setpoint of 71°F (adjustable) and prior to building occupancy, the BMS will start the supply fan. The BMS will run the unit in full return air, and the exhaust fan and energy recovery wheel will remain de-energized. The BMS will modulate the preheat water valve to its maximum open position. The BMS will implement an optimized start-up program to determine when the unit will start for building warm-up.

Occupied Heating Mode: When building temperature setpoint is reached or occupancy time is reached, the BMS will open the outside air damper to its minimum CFM setpoint as measured by the AHU manufacturer's airflow measuring station (which supplies a 4-20 mA signal to the BMS) and start associated exhaust fan and energy recovery wheel. If the mixed air temperature downstream of the energy recovery wheel falls below setpoint, the BMS will modulate the preheat coil water valve open to maintain a discharge air temperature of 55°F (adjustable).

Occupied Economizer Mode: If the mixed air temperature downstream of the energy recovery wheel rises above setpoint and outside air is available for free cooling, the BMS will open the outside air damper. In the economizer mode, the BMS will de-energize the energy recovery heat wheel and modulate the wheel bypass dampers and return air damper to maintain a mixed air temperature setpoint of 55°F (adjustable).

Occupied Cooling Mode: If outside air is not available for free cooling, the BMS will close the wheel bypass dampers, close the outside air damper to its minimum position, and start the energy recovery wheel. The BMS will modulate the chilled water valve to maintain a discharge temperature setpoint of 55°F.

Carbon Dioxide Control: The BMS will modulate the outside air damper position to maintain a 700 ppm differential between outside CO_2 levels and indoor CO_2 levels. Should indoor CO_2 levels rise above 700 ppm above outside CO_2 levels, the BMS system will open the outside air damper to its minimum position. Should indoor CO_2 levels fall below 700 ppm above outside CO_2 levels the BMS system will close the outside air damper below its minimum position to maintain CO_2 setpoint. CO_2 control will be disabled during economizer mode.

Fan Control: The BMS will modulate the supply fan variable speed drive to maintain ? static pressure setpoint subject to discharge high limit. The DDC will modulate the exhaust fan VFD to maintain a calculated differential airflow between the outside air intake CFM and the exhaust air CFM (measured from airflow measuring station in the exhaust air provided by the Control Contractor) to maintain a proper space pressurization.

Unoccupied Mode: All fans will be off, the heat wheel disabled, and the outside air damper closed. The DDC will cycle the respective fan-powered VAV boxes to maintain heating night setback setpoint. AHU may only be indexed to occupied setpoint during unoccupied periods by contacting Newport News Public Schools, School Plant.

Safeties: If products of combustion are detected by the duct smoke detector, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). If a freeze condition is detected by low-limit thermostat in the discharge of the pre-heat coil, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). Interlock wiring and DDC alarm wiring will be by Control Contractor. If DDC detects an anti-rotation alarm from the energy recovery wheel, the alarm will be displayed in Plant Services.

Night Set-back: When the space temperature falls below 60°F in rooms served by fan-powered VAV terminals, the night set-back control will be accomplished by the series fan-powered VAV terminals. The terminal units will be controlled as described in the terminal unit control section.

Supply Air Reset Mode: When the majority of VAV box heating coils control valves are open, the MBC Controller will reset up the supply air temperature in 2°F increments over an adjustable timed period by modulating closed the chilled water coil control valve and the hot water preheat coil control valve open. As long as the majority of VAV box heating coils remain open, the MBC Controller will continue to reset up the supply air temperature until the chilled water coil control valve is closed.

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Revisions

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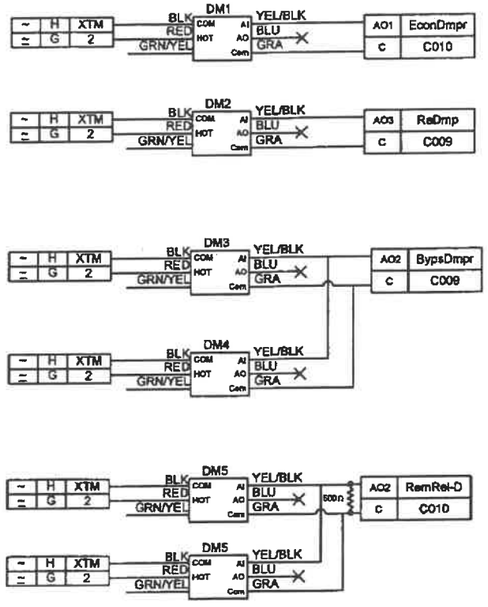
Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

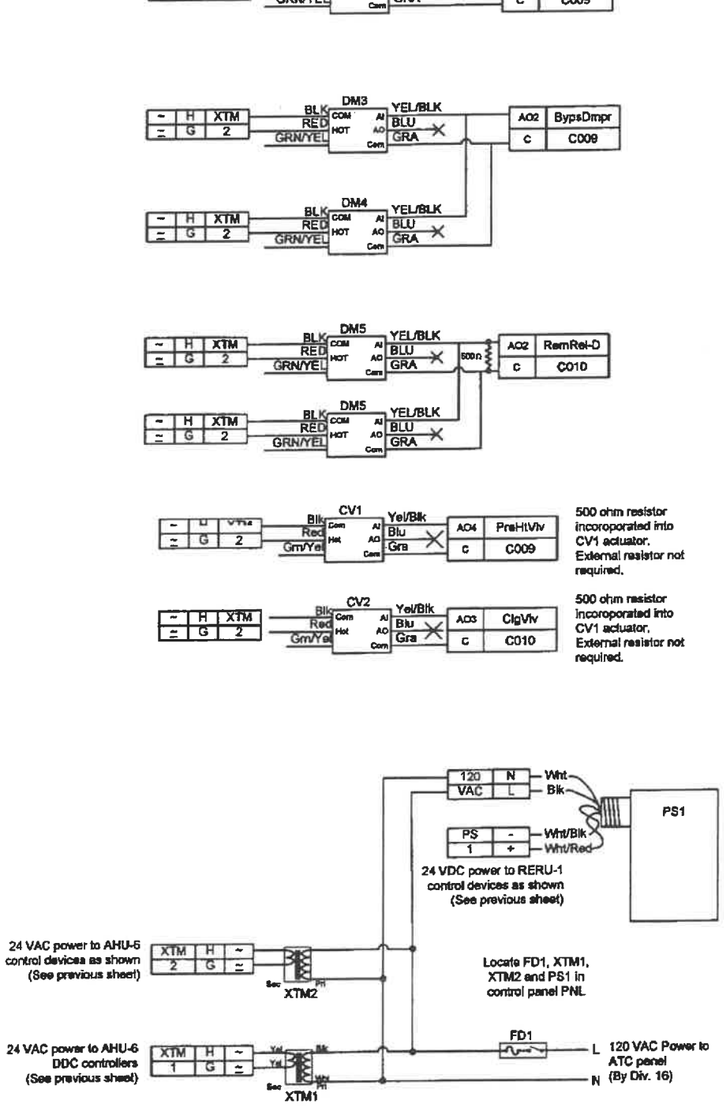
AHU-6 Control (Part 1)

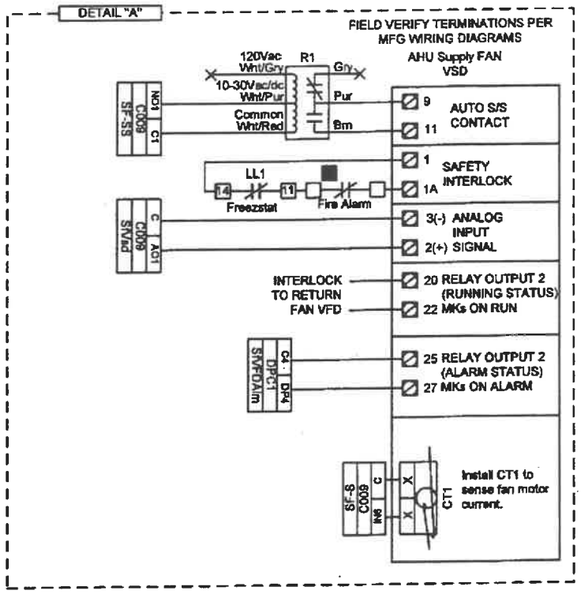
JOB NUMBER PRCC04032
FILE NAME AHU 6.vsd
SHEET NO. 14 OF 39

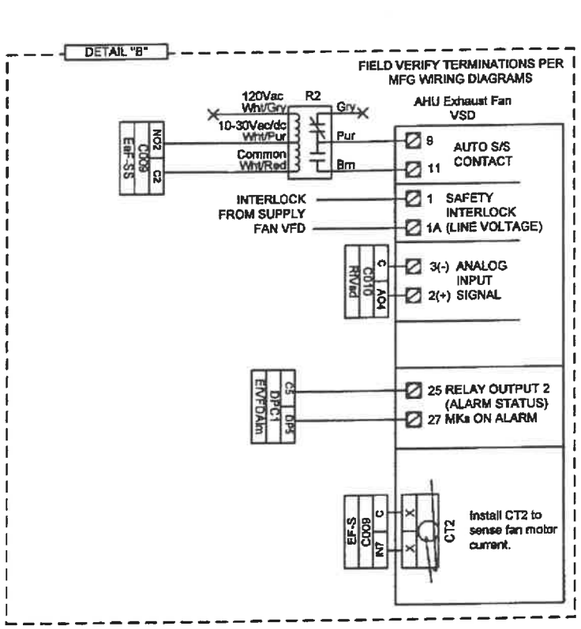


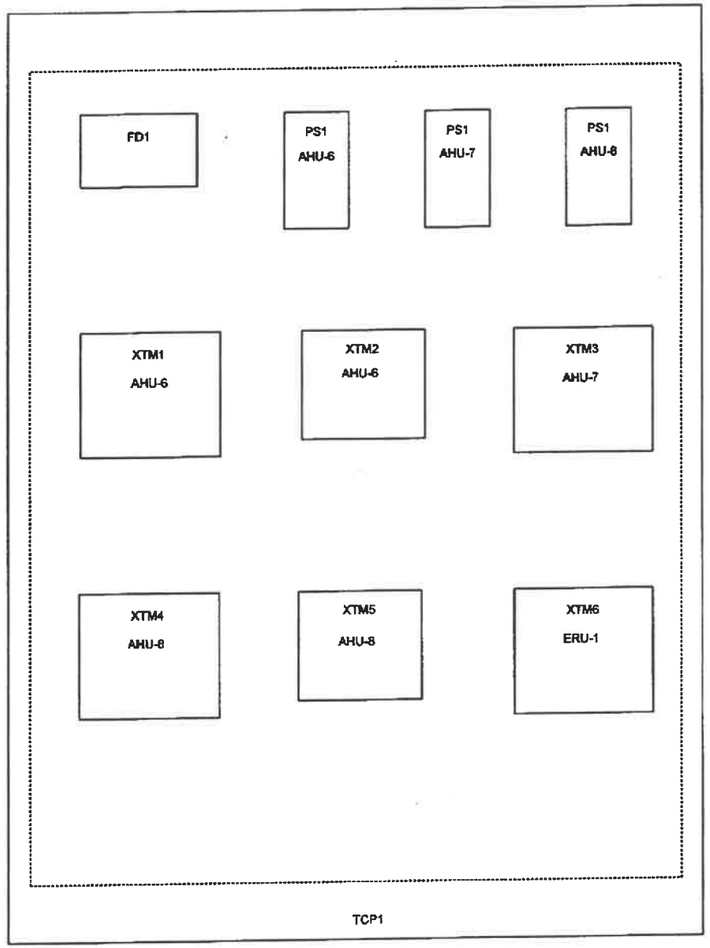
500 ohm resistor incoroporated into CV1 actuator. External resistor not required.

500 ohm resistor incoroporated into CV1 actuator. External resistor not required.









Note: 1 panel PNL will be provided where shown for panel mounted items for RERU-1.

Locate panel where shown on sheet M2.2 roof plan.

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Software by:	Date:
Checked by:	Date:

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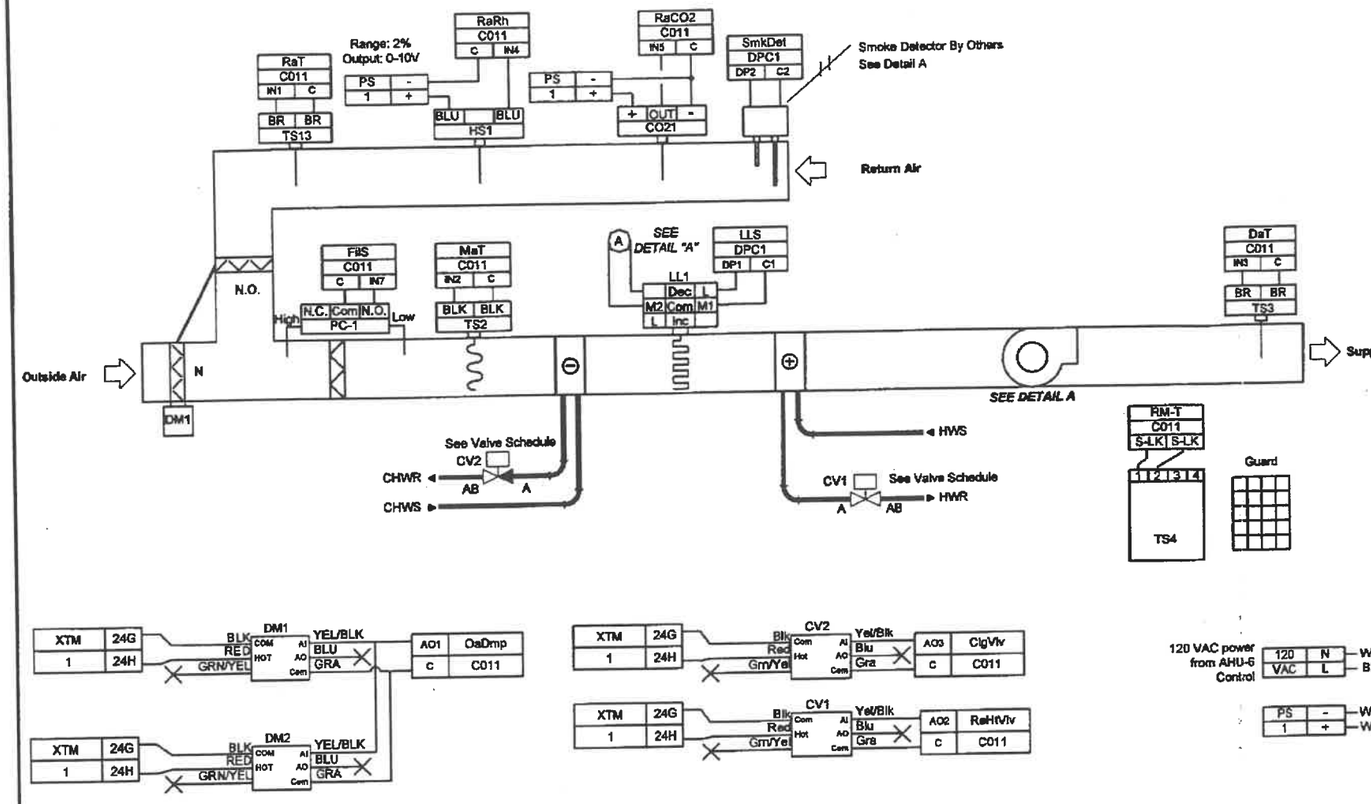
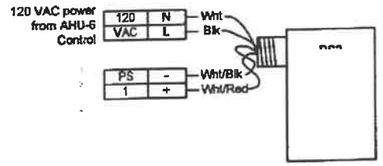
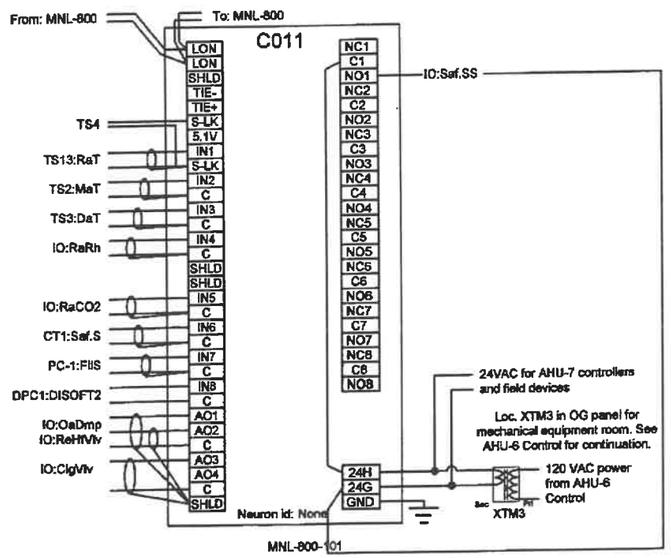
Chesnut Avenue
Newport News, Virginia

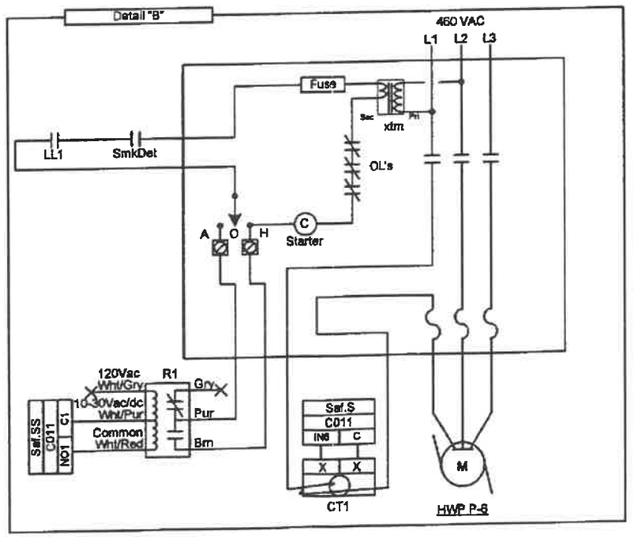
AHU-6 Control (Part 2)

JOB NUMBER PRCC04032
FILE NAME AHU 6.vsd
SHEET NO. 15 OF 39









AHU-7 Control Device	Qty	Part Number	Description	Vendor
C011	1	MNL800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS BLDG SYSTEMS
C011_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
CO21	1	VER-CDXSOX	CO2 Xmtr. 0-2000 ppm 4-20	Single Sourced Solutions
CT1	1	E112-708	ADJ SETPT; TRIP LED; POWER LED	SINGLE SOURCED SOLUTIONS
DM1-2	2	MS40-7073	DIR MT DMP OPR PROP SR 24V 60	INVENSYS BLDG SYSTEMS
DPC1	1	BCS-DPC-5-1	Digital Point Card 5	PS3
Guard	1	AT-1104	TSTAT GUARD, CAST FOR SINGLE S	INVENSYS BLDG SYSTEMS
HS1	1	VER-HDZXMSX	DUCT MTD HUM SEN 2% 4-20MA OUT	SINGLE SOURCED SOLUTIONS
LL1	1	KEL-A70HA-2	FREEZ STAT MAN. RESET DPDT. 35	Kele
PC-1	1	PC-301	PRESSURE CONTROL, ADJ. .05~1.	INVENSYS BLDG SYSTEMS
PC-1_1	1	DYN-DPS-06	AIR FLOW SENS PROB 6"	SINGLE SOURCED SOLUTIONS
PS2	1	KEL-DCP-250-H	120vac/24vdc Power Supply 250	Single Sourced Solutions
R1	1	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
TS2	1	TS-6405	5' AVG. SENSOR 1 K OHM BALCO	INVENSYS BLDG SYSTEMS
TS3,13	2	TS-5721-850	IA MN SNSR-DUCT/IMMERS	INVENSYS BLDG SYSTEMS
TS4	1	MN-S1	IA MICRONET S-LINK SENSOR	INVENSYS BLDG SYSTEMS
XTM3	1	TR100VA001	Control Xfmr. 120vP/24vS 100va	Single Sourced Solutions

CONSTANT VOLUME AIR-HANDLING UNIT (GYM NORMAL OCCUPANCY AHU-7)

Unoccupied Mode: When the building is indexed for unoccupied operation, the DDC will disable the supply fan, close the chilled water control valve, open the heating water control valves, close the outside air and relief air dampers, and open the return air damper.

Night Set-back: When the space temperature falls below 60°F (adj.), the DDC will enable the supply fan and fully open the reheat control valve. When the space temperature rises to 65°F (adj.), the DDC will disable the supply fan. The unit will operate with 100% return air until setpoint is reached.

Night Set-up: When the space temperature rises to 90°F (adj.) or above, the DDC will enable the supply fan and fully open the reheat control valve. When the space temperature falls to 85°F (adj.), the DDC will disable the supply fan and close the chilled water control valve. The unit will operate with 100% return air until setpoint is reached.

Warm-up: When the optimal start program calls for warm-up operation, the DDC will enable the supply fan and fully open the reheat control valve. The unit will operate 100% return air until setpoint is reached.

Cool-down: When the optimal start program calls for cool-down operation, the DDC will enable the supply fan and fully open the Chilled water control valve. The unit will operate with 100% return air until setpoint is reached.

Occupied Mode: When the building is indexed for occupied operation, and the unit is not running on warm-up or cool-down, the DDC will open the outdoor air and relief air dampers, close the return air damper to its minimum outside air position, and enable the supply fan. The actual time for occupied operation will be one hour prior to normal occupancy time to permit an IAQ pre-operation period.

Temperature Control: On a fall in space temperature below setpoint, the DDC will modulate the reheat control valve fully open. On a rise in space temperature, the DDC will modulate the reheat coil control valve closed. On a further rise in the space temperature above setpoint (adj.), the DDC will modulate the chilled water control valve fully open. On a fall in space temperature, the reverse will occur.

Supply Fan Start-up: The supply fan will not be enabled until outside air and relief air dampers are open, as sensed by end switches.

Freeze Protection: Should the chilled water coil leaving air temperature drop to 35°F or below, the low limit thermostat will disable the supply fan, the outside air and relief air dampers will close, the return damper will open, and an alarm generated. The chilled water valve and reheat coil valve will fully open to maintain water flow through coil.

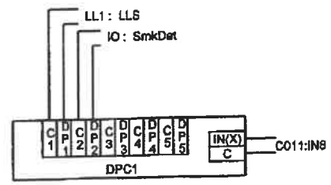
Smoke Control: Should products of combustion be detected, the supply fan will be disabled, the outdoor air and relief air dampers will be closed, and an alarm generated.

Indoor Air Quality Control: When an air-handling unit is indexed for occupied operation, the indoor air quality will be monitored by a Carbon Dioxide (CO_2) sensor located in the return duct of the AHU. The minimum outdoor air introduced into the building will be as shown on the drawings. CO_2 levels will be controlled to maintain a maximum differential between the indoor and outdoors of 700 ppm by indexing AHU-8 (high occupancy unit). Refer to AHU-8 sequence of operation for energizing.

Dehumidification: On a detection of high humidity (above 60% RH), AHU-7 will go into dehumidification mode. The DDC controller will modulate the chilled water valve fully open. The supply fan will modulate to maintain space temperature. Should the supply fan reach 50% of the total CFM (as measured by the Air Balancing Contractor and pre-set at the VFD) while the chilled water valve is fully open and the space falls below setpoint, the DDC will modulate the reheat valve open to maintain space temperature. Once the humidity setpoint is reached (5% below setpoint of 55% RH), the AHU will return to normal operation.

Remote Relief Damper Control: The relief damper will open whenever the outside air damper is open.

Remote Outside Air Damper: The outside air damper will open whenever the AHU is enabled for occupied operation.



Dominion Energy Management inc.
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Authorized Invensys Representative

Revisions

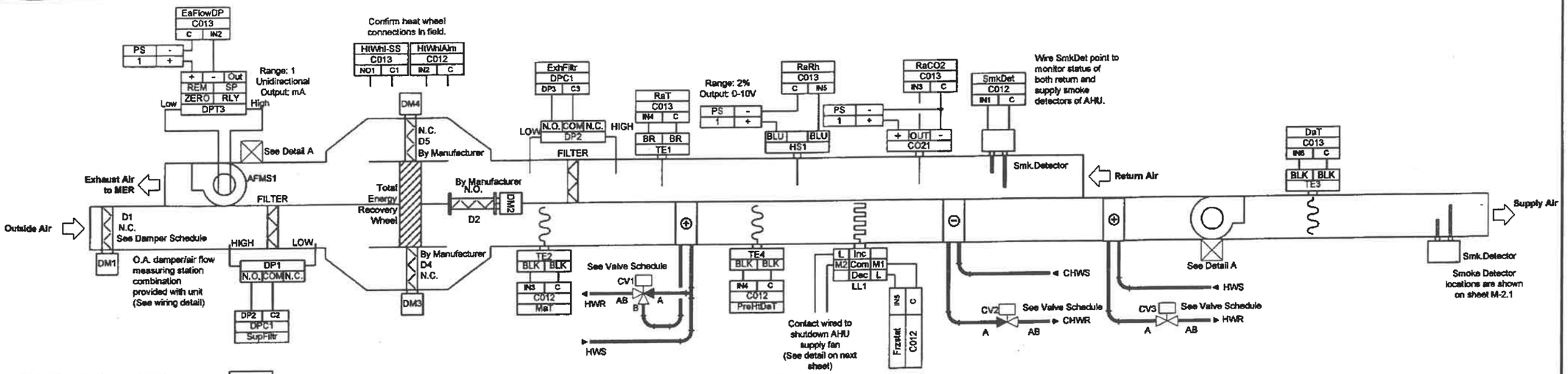
#	Change:	Date:

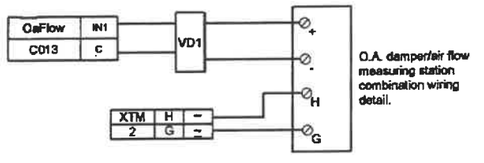
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

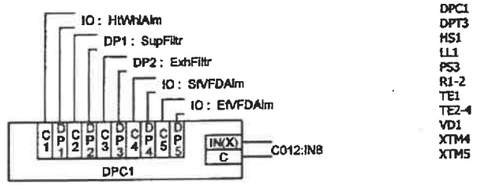
AHU-7 Control

Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

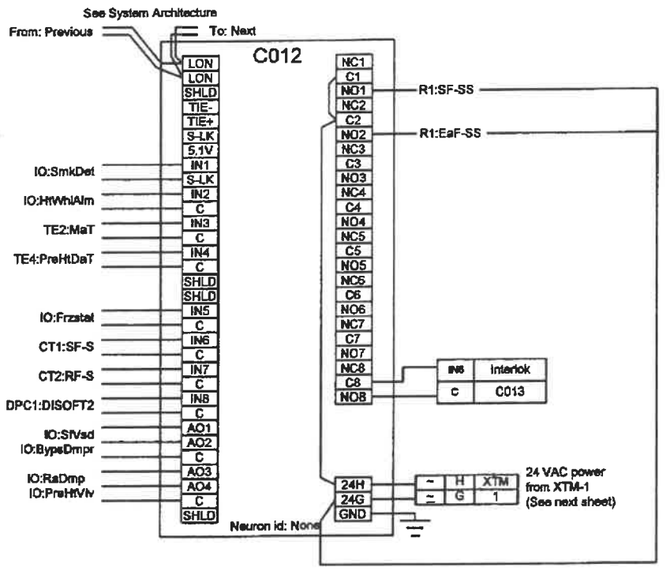
JOB NUMBER PRCC04032
FILE NAME AHU7.vwd
SHEET NO. 16 OF 39

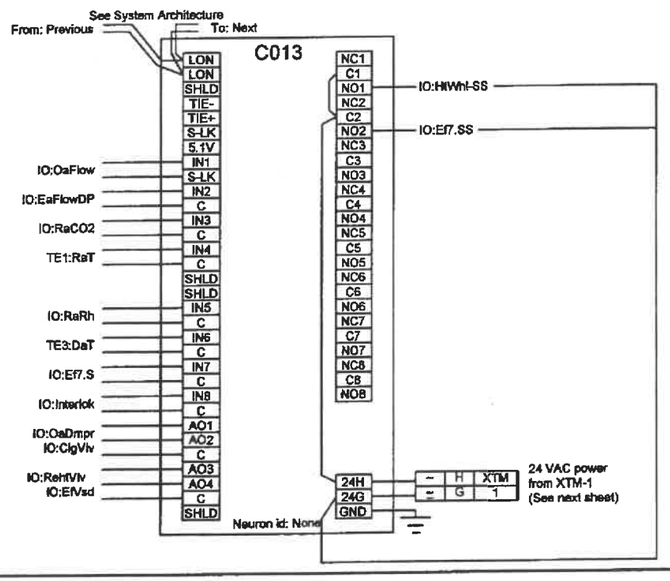






AHU-8 Control Device	Qty	Part Number	Description · Vendor
AFMS1	1	FIAMP	Fan Inlet Air Flow Station Single Sourced Solutions
CO12-013	2	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC INVENSYS BLDG SYSTEMS
CO12_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W INVENSYS BLDG SYSTEMS
CO13_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W INVENSYS BLDG SYSTEMS
CO21	1	VER-CDXSOX	CO2 Xmtr. 0-2000 ppm 4-20 Single Sourced Solutions
CT1-2	2	CS1150A-1ED	Adj. Current Sensing Relay Kele and Associates
DM1-4	4	MS40-7153	DIR MT DMP OPR PROP SR 24V 133 INVENSYS BLDG SYSTEMS
DP1-2	2	PC-301	PRESSURE CONTROL, ADJ. .05~1. INVENSYS BLDG SYSTEMS
DPC1	1	BCS-DPC-5-1	Digital Point Card 5 PS3
DPT3	1	VER-PXP0X01S	DIFF PRES SEN DRY MEDIA PNL MT SINGLE SOURCED SOLUTIONS
HS1	1	VER-HD2XMSX	DUCT MTD HUM SEN 2% 4-20MA OUT SINGLE SOURCED SOLUTIONS
LL1	1	KEL-A70HA-2	FREEZ STAT MAN. RESET DPDT. 35 Kele
PS3	1	KEL-DCP-250-H	120vac/24vdc Power Supply 250 Single Sourced Solutions
R1-2	2	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10 SINGLE SOURCED SOLUTIONS
TE1	1	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER INVENSYS BLDG SYSTEMS
TE2-4	3	TS-8422	22' AVG. SENSOR 1 K OHM BALCO INVENSYS BLDG SYSTEMS
VD1	1	Special	Voltage Divider Local
XTM4	1	TR50VA001	Control Xfmr. 120vP/24vS 50va Single Sourced Solutions
XTM5	1	TR100VA001	Control Xfmr. 120vP/24vS 100va Single Sourced Solutions





SEQUENCE OF OPERATION

CONSTANT VOLUME AIR-HANDLING UNITS (GYM HIGH OCCUPANCY AHU-8)

Unoccupied Mode: When the building is indexed for unoccupied operation, the DDC will disable the supply and exhaust fans, close the chilled water control valve, open the heating water control valves, close the outside air and exhaust air dampers, and open the return air damper. The DDC will disable all associated exhaust fans.

Night Set-back: Night set-back will be accomplished by AHU-7.

Night Set-up: Night set-up will be accomplished by AHU-7.

Warm-up: Warm-up will be accomplished by AHU-7.

Cool-down: Cool-down will be accomplished by AHU-7.

Occupied Mode: When the building is indexed for occupied operation and there is a demand for temperature or CO_2 control from AHU-7, the DDC will open the outdoor air and exhaust air dampers, close the return air damper to its minimum outside air position, and enable the supply and exhaust fans and energy recovery wheel (see the supply and exhaust fan start-up sequence below). AHU-8 will be sequenced with AHU-7 DDCed on space temperature setpoint or space CO_2 setpoint. Should temperature rise above or fall below setpoint or space CO_2 rise above setpoint, the DDC will index the air-handling unit to occupied mode. Note: Initial setpoint for AHU-8 should be a minimum of 2°F above or below temperature setpoint and 400 ppm above CO_2 setpoint of AHU-7.

Temperature Control: On a fall in space temperature below setpoint, the DDC will modulate the reheat control valve fully open. On a rise in space temperature, the DDC will modulate the reheat coil control valve closed. On a further rise in space temperature above setpoint (adj.), the DDC will modulate the chilled water control valve fully open. On a fall in space temperature, the reverse will occur.

Preheat Coil Control: On a fall in preheat coil discharge air temperature below setpoint (55°F adjustable), the DDC will modulate the preheat control valve fully open. On a rise in preheat coil discharge air temperature, the DDC will modulate the reheat coil control valve closed.

Supply Fan Start-up: The supply fan will not be enabled until outside air and exhaust air dampers are open, as sensed by end switches.

Exhaust Fan Start-Stop Control: The exhaust fan will be enabled and disabled simultaneously with and in a manner as described for the supply air fans. The DDC will modulate the exhaust fan VFD to maintain a calculated differential airflow between the outside air intake CFM and the exhaust air CFM (measured from airflow measuring station in the exhaust air provided by the Control Contractor) to maintain a proper space pressurization.

Occupied Economizer Mode: If the mixed air temperature downstream of the energy recovery wheel rises above setpoint and outside air is available for free cooling, the BMS will open the outside air damper. In the economizer mode, the BMS will de-energize the energy recovery heat wheel and modulate the wheel bypass dampers and return damper to maintain mixed air temperature setpoint of 55°F (adjustable).

Indoor Air Quality Control: AHU-8 will be activated by CO_2 sensor located in AHU-7's return ductwork. The minimum outdoor air introduced into the building will be varied between 0 CFM and the minimum outside air CFM shown on the drawings. CO_2 levels will be controlled by modulating the outdoor air and return air dampers to maintain a maximum differential between the indoor and outdoor of 700 ppm.

Heat Wheel Control: Whenever the unit fans are running, the DDC will enable the heat wheel to run under its own control system. Whenever the heat wheel controller goes into alarm, the DDC will send an alarm to Plant Services.

Safeties: If products of combustion are detected by the duct smoke detector, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). If a freeze condition is detected by low-limit thermostat in the discharge of the pre-heat coil, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan(s). Interlock wiring and DDC alarm wiring will be by Control Contractor. If DDC detects an anti-rotation alarm from the energy recovery wheel, the alarm will be displayed in Plant Services.

Remote Relief Damper Control: The relief damper will open whenever the outside air damper is open.

Remote Outside Air Damper: The outside air damper will open whenever the AHU is enabled for occupied operation.

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Authorized Invensys Representitive

Revisions

#	Change:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

AHU-8 Control (Part 1)

JOB NUMBER PRCC04032
FILE NAME AHU 8.vsd
SHEET NO. 17 OF 39

500 ohm resistor incoroporated into CV1 actuator. External resistor not required.

500 ohm resistor incoroporated into CV2 actuator. External resistor not required.

500 ohm resistor incoroporated into CV3 actuator. External resistor not required.

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Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

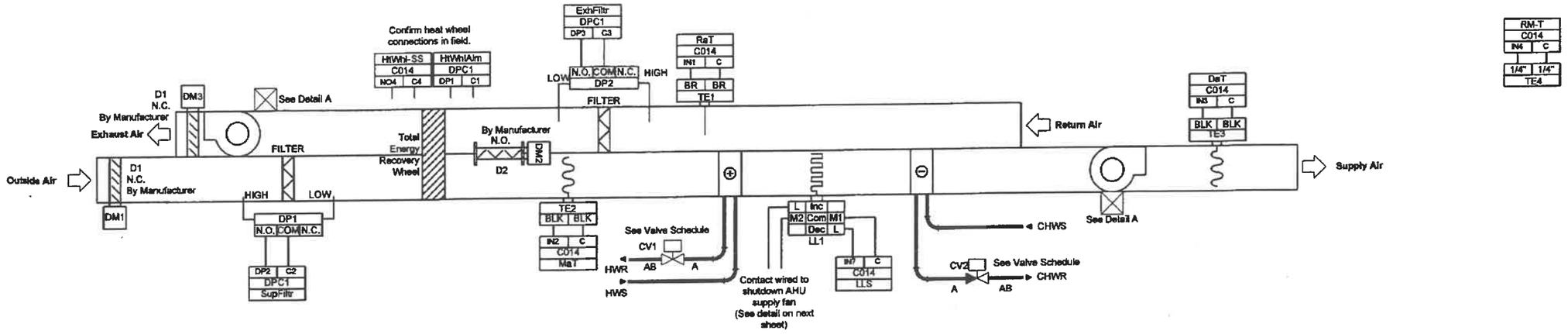
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

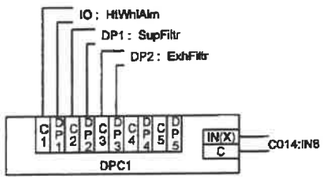
AHU-8 Control (Part 2)

JOB NUMBER PRCC04032

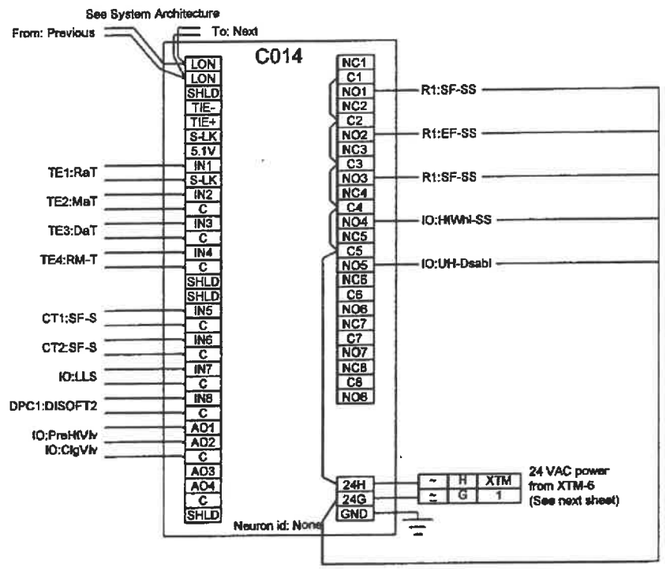
FILE NAME AHU 8.vwd

SHEET NO. 18 OF 39





ERU-1 Control Device	Qty	Part Number	Description	Vendor
C014	1	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS BLDG SYSTEMS
C014_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
CT1-2	2	E112-708	ADJ SETPT; TRIP LED; POWER LED	SINGLE SOURCED SOLUTIONS
DM1-3	3	MA40-7073	DIR MT DMP OPR 2 POS SR 24V 60	INVENSYS BLDG SYSTEMS
DP1-2	2	PC-301	PRESSURE CONTROL, ADJ. .05~1.	INVENSYS BLDG SYSTEMS
DPC1	1	BCS-DPC-5-1	Digital Point Card 5	PS3
ENCL1	1	KEL-HC18126P	18x12x6 Nema 1 Enclosure w/Sub	Kele and Associates
ES1-3	3	P-370	DAMPER END SWITCH	INVENSYS BLDG SYSTEMS
LL1	1	KEL-A70HA-2	FREEZ STAT MAN. RESET DPDT. 35	Kele
R1-2	2	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
R3	1	FUN-RIB24-01D	Relay	SINGLE SOURCED SOLUTIONS
TE4	1	BAP-10K-3(11K)-SP	WALL PLATE 2X4" STLS STL, INSU	SINGLE SOURCED SOLUTIONS
TE1	1	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER	INVENSYS BLDG SYSTEMS
TE2-3	2	TS-8422	22' AVG. SENSOR 1 K OHM BALCO	INVENSYS BLDG SYSTEMS
XTM6-7	2	TR50VA001	Control Xfmr. 120vP/24vS 50va	Single Sourced Solutions



SEQUENCE OF OPERATION

ENERGY RECOVERY UNIT (LOCKER ROOMS ERU-1)

Unoccupied Mode: When the building is indexed for unoccupied operation, the DDC will disable the supply and exhaust fans, close the chilled water control valve, open the heating water control valves, close the outside air and exhaust air dampers, and open the return air bypass damper. The DDC will disable all associated exhaust fans.

Night Set-back: When the space temperature falls below 60°F (adj.), the DDC will enable the supply fan and fully open the heating coil control valve. When the space temperature rises to 65°F (adj.), the DDC will disable the supply fan. The unit will operate with 100% bypass return air until setpoint is reached.

Night Set-up: When the space temperature falls below 90°F (adj.), or above, the DDC will enable the supply fan and fully open the chilled water control valve. When the space temperature falls to 85°F (adj.), the DDC will disable the supply fan and close the chilled water control valve. The unit will operate with 100% bypass return air until setpoint is reached.

Warm-up: When the optimal start program calls for warm-up operation, the DDC will enable the supply fan and fully open the chilled water control valve. The unit will operate with 100% bypass return air until setpoint is reached.

Cool-down: When the optimal start program calls for cool-down operation, the DDC will enable the supply fan and fully open the chilled water control valve. The unit will operate with 100% bypass return air until setpoint is reached.

Occupied Mode: When the building is indexed for occupied operation, the DDC will open the outdoor air and exhaust air dampers, close the bypass return air damper, and enable the supply and exhaust fans and energy recovery wheel (see the supply and exhaust fan start-up sequence below).

Temperature Control: On a fall in space temperature below setpoint, the DDC will modulate the heating coil (preheat position) control valve fully open. On a rise in space temperature, the DDC will modulate the heating coil control valve closed. On a further rise in the space temperature above setpoint (adj.), the DDC will modulate the chilled water control valve fully open. On a fall in space temperature, the reverse will occur.

Supply Fan Start-up: The supply fan will not be enabled until outside air and exhaust air dampers are open, as sensed by end switches.

Exhaust Fan Start-Stop Control: The exhaust fan will be enabled and disabled simultaneously with and in a manner as described for the supply air fans.

Heat Wheel Control: Whenever the unit fans are running, the DDC will enable the heat wheel to run under its own control system. Whenever the heat wheel controller goes into alarm, the DDC will send an alarm to Plant Services.

Safeties: If a freeze condition is detected by low-limit thermostat in the discharge of the heating coil, the DDC will be alarmed, and the unit will be de-energized along with associated exhaust fan. Interlock wiring and DDC alarm wiring will be by Control Contractor. If DDC detects an anti-rotation alarm from the energy recovery wheel, the alarm will be displayed in Plant Services.

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Revisions

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Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
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Checked by: Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

ERU-1 Control (Part 1)

JOB NUMBER PRCC04032
FILE NAME ERU 1.vsd
SHEET NO. 19 OF 39

Dominion Energy Management Inc.
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Authorized Invensys Representitive

Revisions

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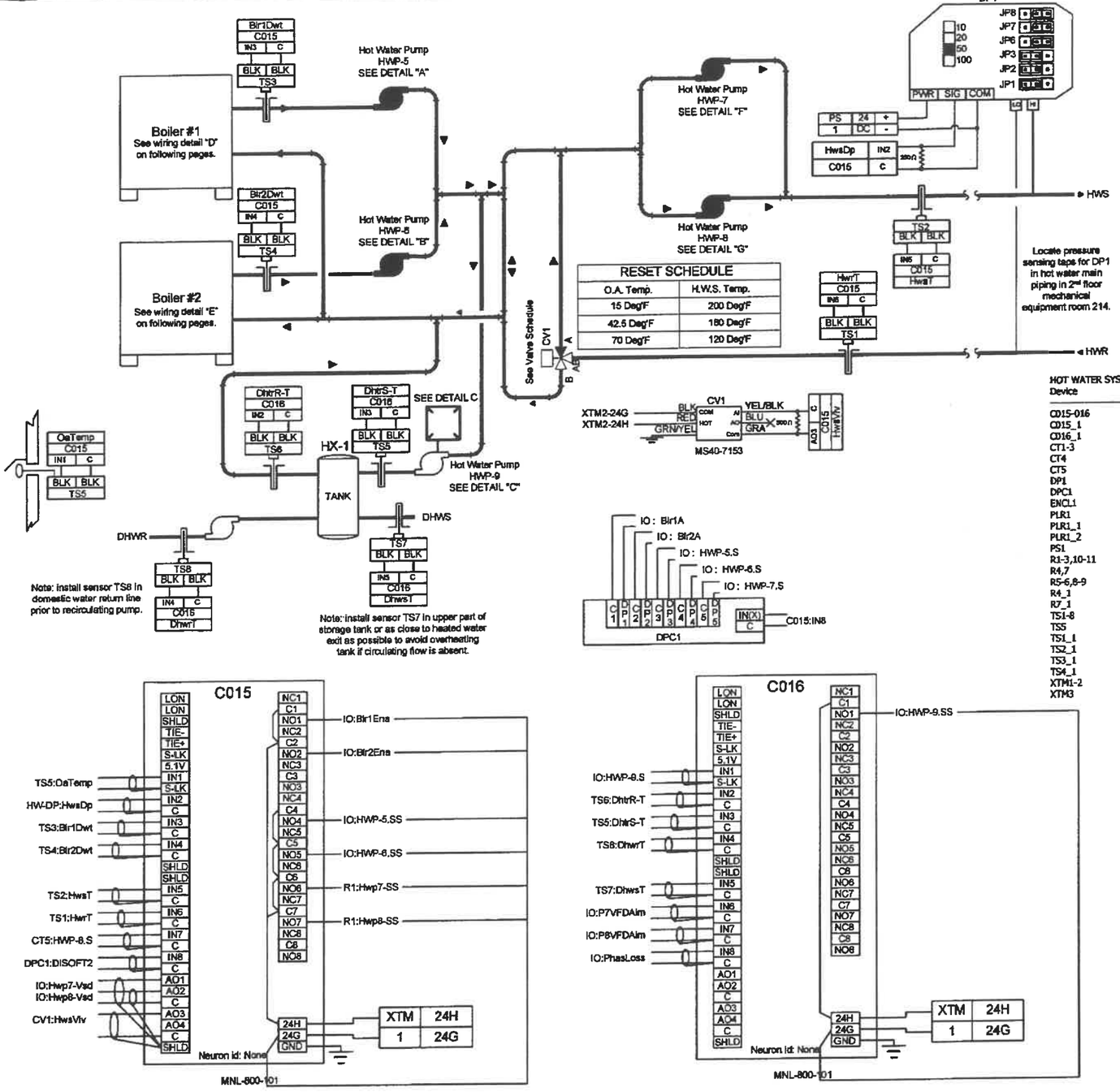
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

ERU-1 Control (Part 2)

Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

JOB NUMBER PRCC04032
FILE NAME ERU 1.vwd
SHEET NO. 20 OF 39



SEQUENCE OF OPERATION

HOT WATER SYSTEM CONTROLS

The hot water system will be enabled continuously. The DDC Controller will energize the lead boiler and its respective hot water pump, and main secondary hot water pump. On a fall in hot water supply temperature, the DDC Controller will stage on boilers to maintain setpoint. The DDC System will reset the heating water supply temperature inversely with respect to outside air temperature by controlling the position of the 3-way reset control valve. Whenever the lead boiler cannot maintain the reset setpoint, the DDC Controller will enable the lag boiler and lag primary pump.

The DDC Controller will select a boiler and its respective primary pump weekly to act as the lead, indexing the other boiler/pump as a lag. Whenever the DDC Controller senses that the lead boiler has an alarm, the DDC Controller, after a time delay (adjustable), will start the lag boiler. If either boiler fails to start, the DDC will alarm Plant Services, and the standby boiler will be started automatically.

The DDC Controller will select a different secondary hot water pump weekly to act as the main, indexing the other pump as a standby. Whenever the DDC Controller senses that the secondary hot water pump has lost flow, the DDC Controller, after a time delay (adjustable), will start the standby pump. If either pump fails to start, the DDC will alarm Plant Services, and the standby pump will be started automatically.

On a fall in downstream differential pressure to the setpoint of the DDC Controller, the DDC Controller will supply a voltage input to the main secondary hot water pump variable frequency drive (VFD). The DDC Controller will continuously monitor the hot water valve position on all modulating hot water valves and reset the downstream differential pressure setpoint so that at least on hot water valve is at least 95% open.

Whenever the outside air temperature falls below 40°F, the hot water system will be enabled.

Water Heater: Water heater and associated re-circulation pump, P-9 will be enabled/disabled through the DDC. The DDC will monitor HW temperatures and cycle the pump to maintain setpoint (140°F) and utilize a time- of-day control. The DDC will send an alarm signal on a failure of a pump or water heater.

HOT WATER SYSTEM

Device	Qty	Part Number	Description	Manufacturer
CD15-016	2	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS- AUTOMATION
CD15_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS- COMPONENTS
CD16_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS- COMPONENTS
CT1-3	3	E112-708	ADJ SETPT; TRIP LED; POWER LED	VERIS
CT4	1	KEL-CS1150A-LED	VFD Current Sensing Relay	Nelsien and Kuljien
CT5	1	CS1150A-LED	Adj. Current Sensing Relay	Kele and Associates
DP1	1	VER-PW0004S	PRESSURE XDUCER,WET TO WET,50/	VERIS
DPC1	1	BCS-DPC-5-1	Digital Point Card 5	BCS
ENCL1	1	KEL-HC18126P	18x12x6 Nema 1 Enclosure w/Sub	Hoffman
PLR1	1	A2588	480 Volt Phase Loss Relay	TimeMark
PLR1_1	1	KEL-RB08-PC	Octal Relay Socket	Kele
PLR1_2	1	KEL-SC886	8x8x6 Screw Cover Box	Kele and Associates
PS1	1	P5-200-1-A-1	1.5 A, 24 VDC POWER SUPPLY (11	MANAC SYSTEMS
R1-3,10-11	5	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 1D	LECTRO / IDEC
R4,7	2	P-125-1-M	ENCLOSED PLUG-IN MIDGET SPDT R	IDEC
R5-6,8-9	4	P-125-2-M	ENCLOSED PLUG-IN MIDGET SPDT R	IDEC
R4_1	1	P-103-8-M	ENCLOSED PLUG-IN 5 TERMINAL S	IDEC
R7_1	1	P-103-8-M	ENCLOSED PLUG-IN 5 TERMINAL S	IDEC
TS1-8	8	TS-8201-106	4" IMMERS. SENSOR 1 K OHM BAL	INVENSYS- COMPONENTS
TS5	1	TS-8501	OUTDOOR SENSOR 1 K OHM BALCO	INVENSYS- COMPONENTS
TS1_1	1	AT-225	SS. WELL - 4"	INVENSYS- COMPONENTS
TS2_1	1	AT-225	SS. WELL - 4"	INVENSYS- COMPONENTS
TS3_1	1	AT-225	SS. WELL - 4"	INVENSYS- COMPONENTS
TS4_1	1	AT-225	SS. WELL - 4"	INVENSYS- COMPONENTS
XTM1-2	2	TR100VA001	Control Xfmr. 120vP/24vS 100va	Functional Devices
XTM3	1	TR50VA001	Control Xfmr. 120vP/24vS 50va	Functional Devices

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Revisions

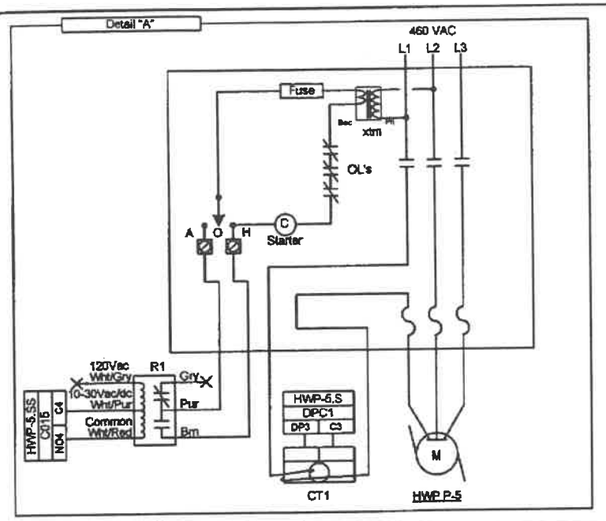
#	Change:	Date:

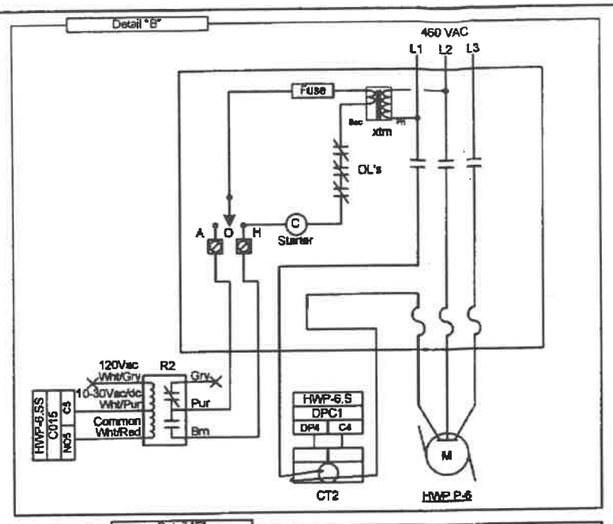
Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

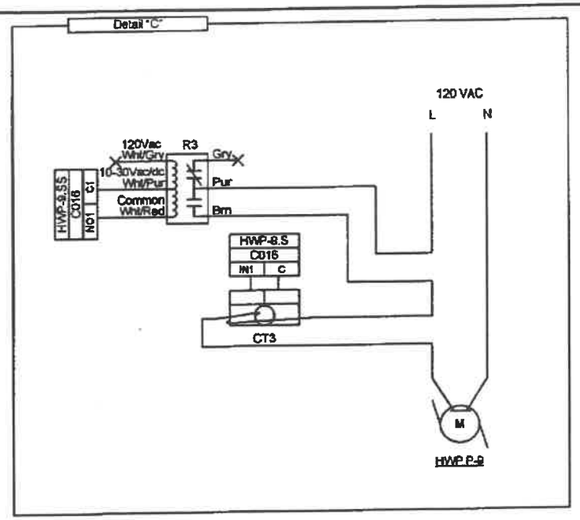
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

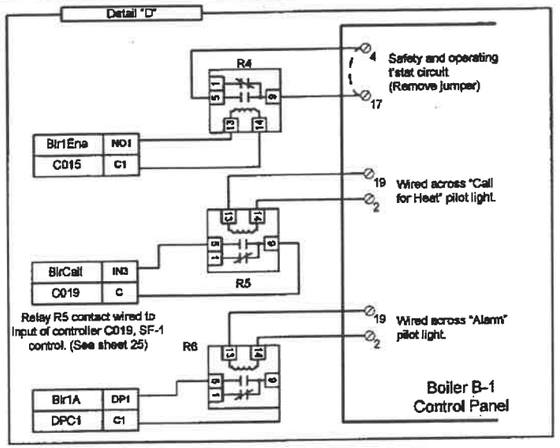
HW System Flow Diagram

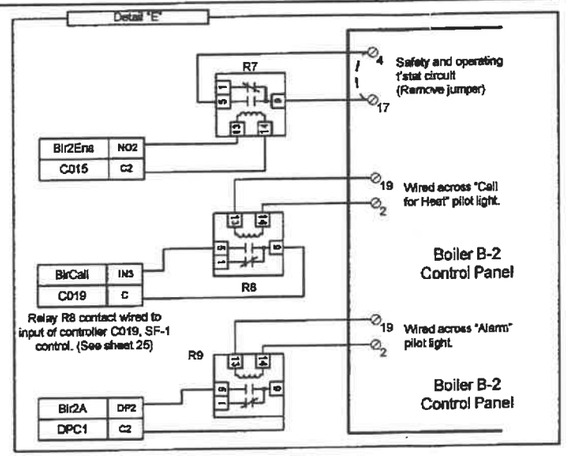
JOB NUMBER PRCC04032
FILE NAME HotWSys.vsd
SHEET NO. 21 OF 39

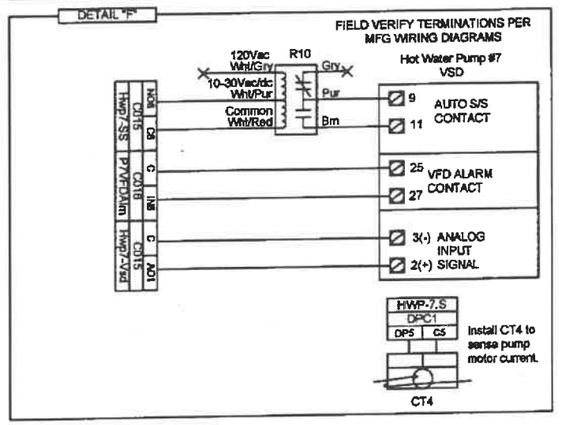


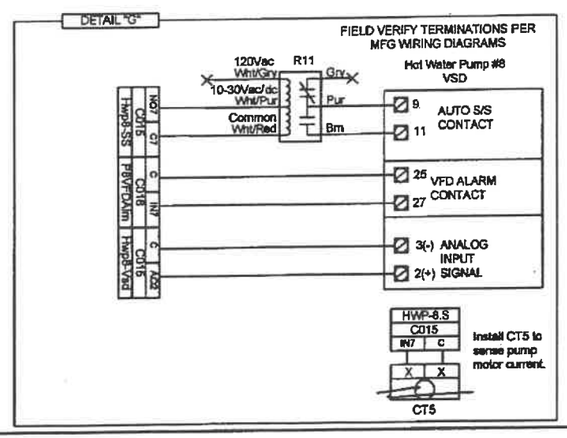


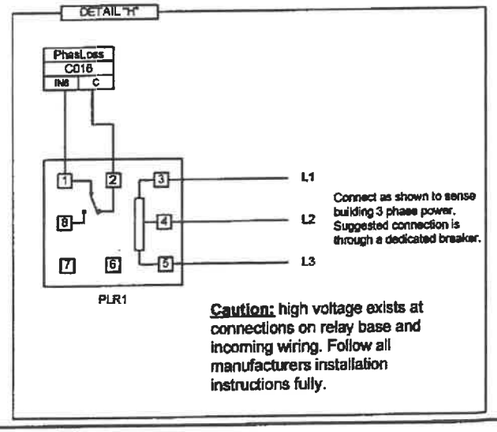








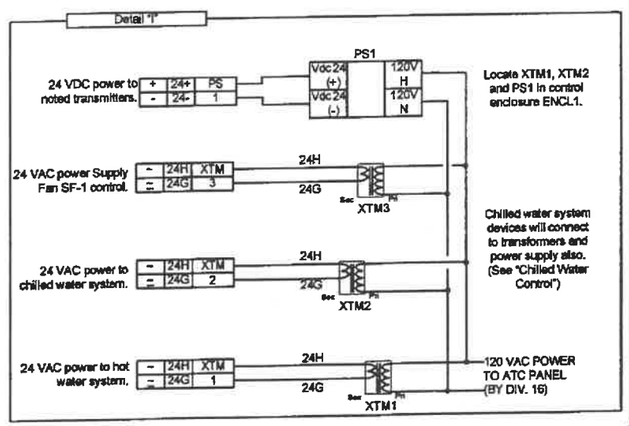




Locate ENCL1 in boiler room where shown. Enclosure contains transformers and power supply for hot water and chilled water system controls.

ENCL1

See previous sheet for sequence of operation.



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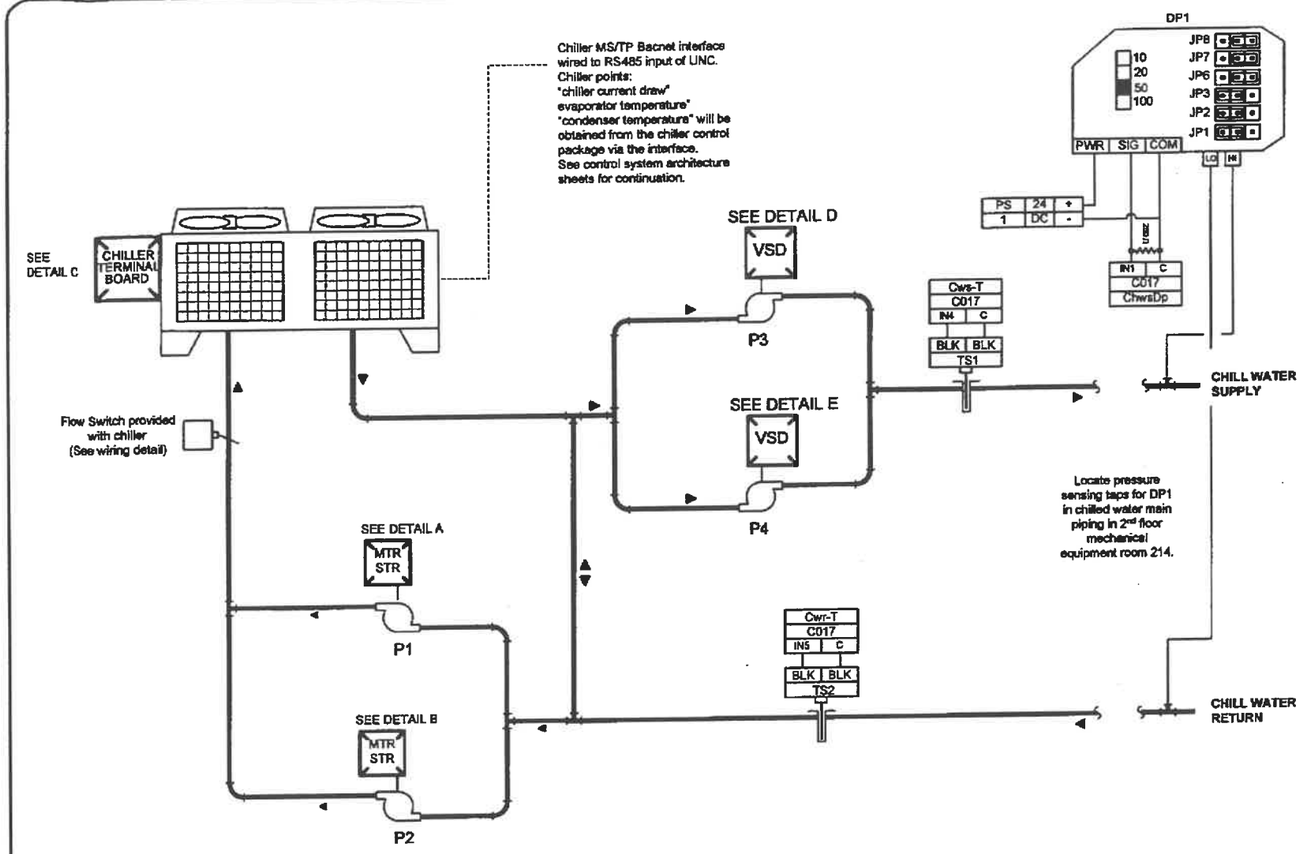
Revisions

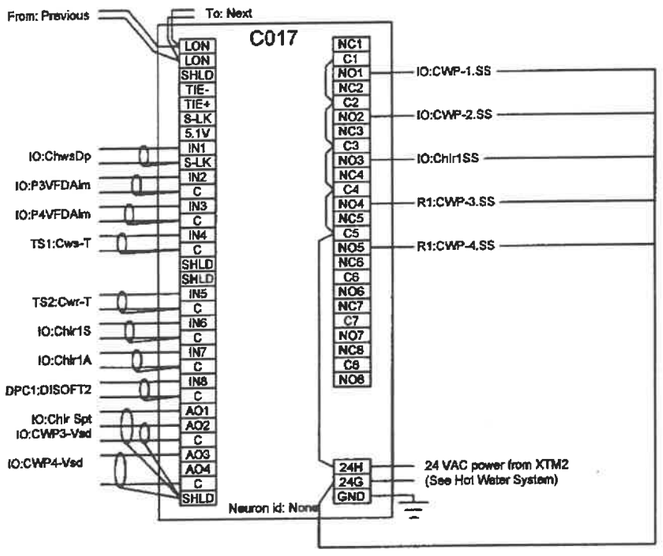
#	Change:	Date:

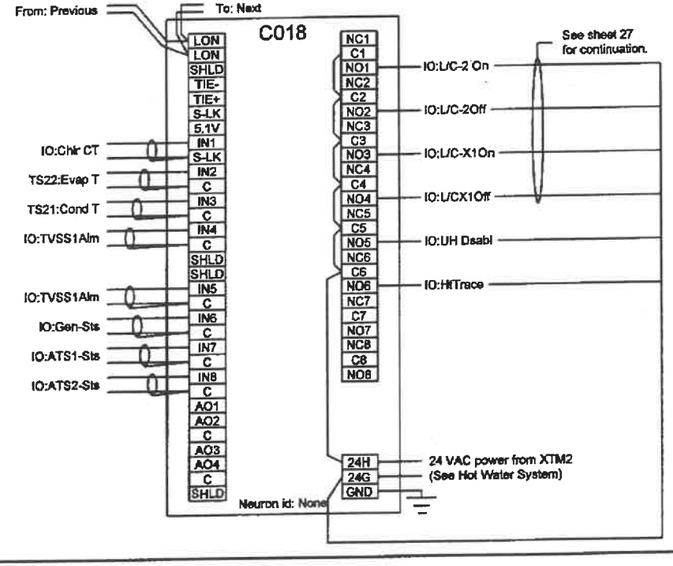
Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia
HW System Control (Part 2of3)

JOB NUMBER PRCC04032
FILE NAME HotWSys.vsd
SHEET NO. 22 OF 39







Chilled Water System Device	Qty	Part Number	Description	Vendor
C017-018	2	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS BLDG SYSTEMS
C017_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
C018_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
CT1-2	2	E112-708	ADJ SETPT; TRIP LED; POWER LED	SINGLE SOURCED SOLUTIONS
CT3-4	2	KEL-CS1150A-LED	VFD Current Sensing Relay	Kele and Associates
DP1	1	VER-PW0X004S	PRESSURE XDUCER,WET TO WET,50/	SINGLE SOURCED SOLUTIONS
DPC1	1	BCS-DPC-5-1	Digital Point Card 5	PS3
R1-5	5	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
R6	1	AE-304	PWR RELAY-24V DPDT-16 AMP@120V	INVENSYS BLDG SYSTEMS
R6_1	1	AE-300	POWER RELAY ENCLOSURE FOR AE-3	INVENSYS BLDG SYSTEMS
TS1-2	2	TS-8201-106	4" IMMERS. SENSOR 1 K OHM BAL	INVENSYS BLDG SYSTEMS
TS1_1	1	AT-225	SS. WELL - 4"	INVENSYS BLDG SYSTEMS
TS2_1	1	AT-225	SS. WELL - 4"	INVENSYS BLDG SYSTEMS

SEQUENCE OF OPERATION

CHILLED WATER SYSTEM CONTROLS:

During the occupied mode, whenever the outside air temperature rises to the setpoint of the DDC Controller, the DDC Controller will enable the main chilled water pump and the chiller

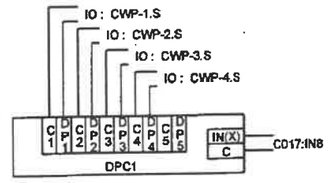
The DDC Controller will monitor chiller current draw, evaporator temperature, and condenser temperature on each chiller. Whenever any of the above three variables reaches setpoint, the DDC Controller will reset the leaving water supply setpoint on its respective control will be utilized for the above sequence. If chiller fails to start, the DDC will alarm Plant Services.

On a signal from the chiller, the DDC will enable the pump's VFD to its minimum flow speed. On a signal from the chiller water temperature rises above setpoint, the VFD will modulate the pump to full flow. Should VFD safety controls stop the pump, a manual reset action will be required before the pump can restart. If the selected lead pump's proof switch does not detect flow within 30 seconds from the start signal, the DDC will de-energize the failed pump, start the stand-by pump, and transmit a pump failure alarm message to the Central Computer Operator Workstation and alarm printer. The stand-by pump will start and run as necessary to maintain the differential pressure at setpoint. A programmed anti-recycle timer will prevent pump short cycling. The DDC will alternate lead and stand-by pumps on a weekly basis.

The DDC Controller will select a different secondary chilled water pump weekly to act as the main, indexing the other pump as a standby. Whenever the DDC Controller senses that the secondary chilled water pump has lost flow, the DDC Controller, after a time delay (adjustable), will start the standby pump.

On a fall in downstream differential pressure to the setpoint of the DDC Controller, the DDC Controller will supply a voltage input to the main secondary chilled water pump variable frequency drive (VFD). The DDC Controller will continuously monitor the chilled water valve position on all chilled water valves and reset the downstream differential pressure setpoint. The DDC will modulate the chilled water bypass (3-way) valve to maintain minimum flow.

Heat Trace: Heat trace will be activated through the DDC. When the outside air temperature drops to 40°F or less, the heat trace will be activated. Local indication will be by a pilot light mounted on a wall of the mechanical room.



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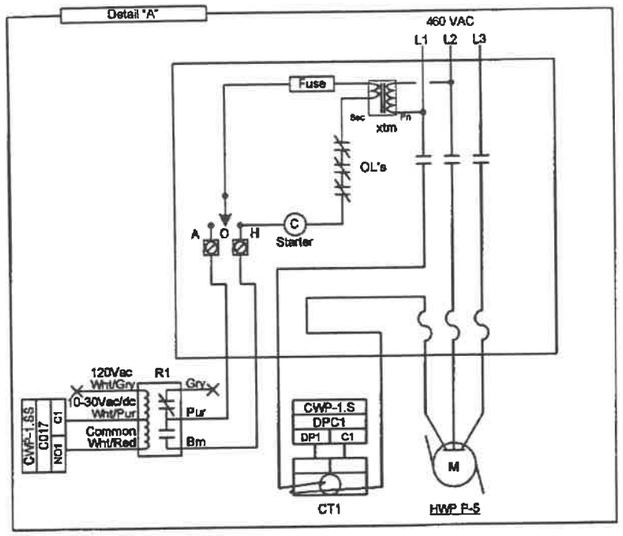
Revisions		
#	Change:	Date:

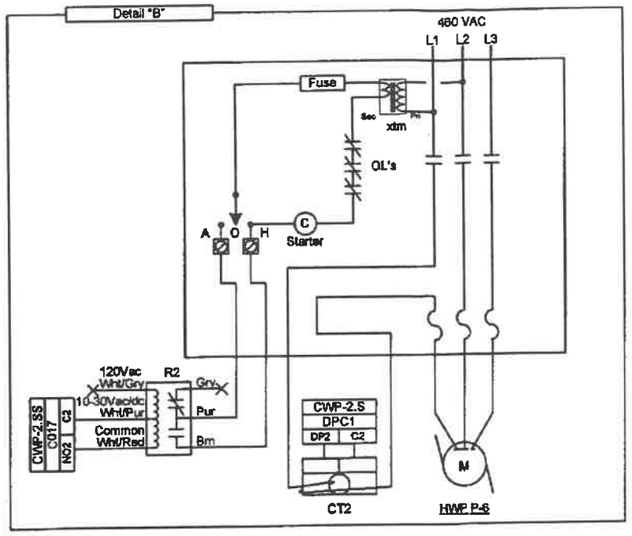
JOB NUMBER PRCC04032
FILE NAME CHWSYS.vsd
SHEET NO. 23 OF 39

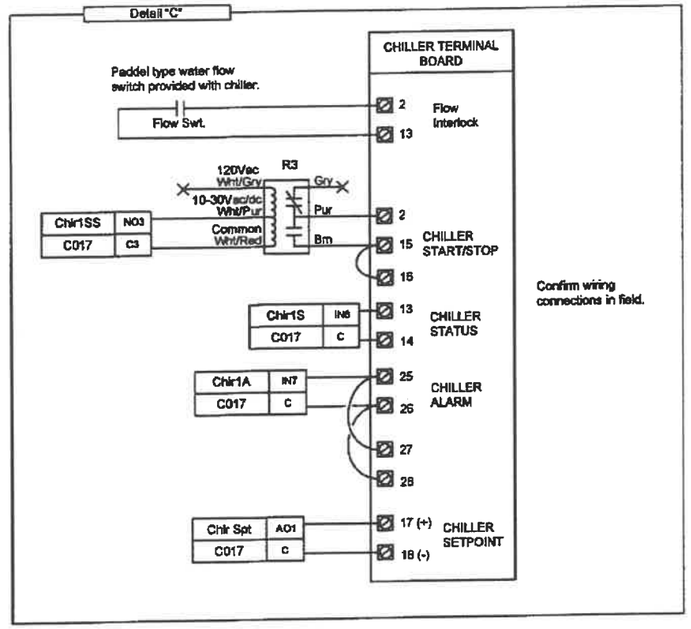
Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

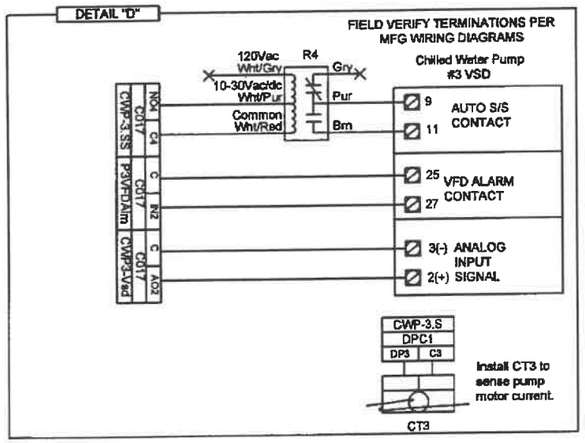
Ch W System Control (Part 1)

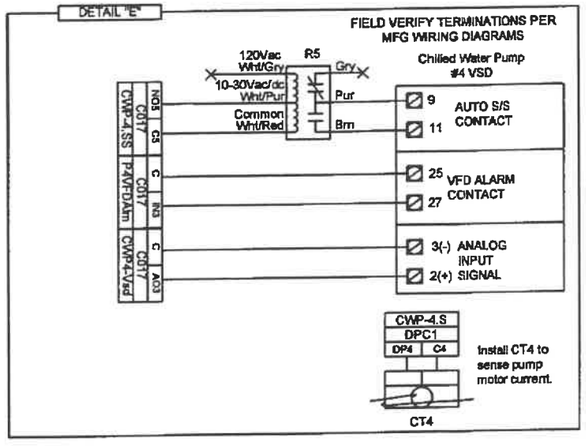
Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

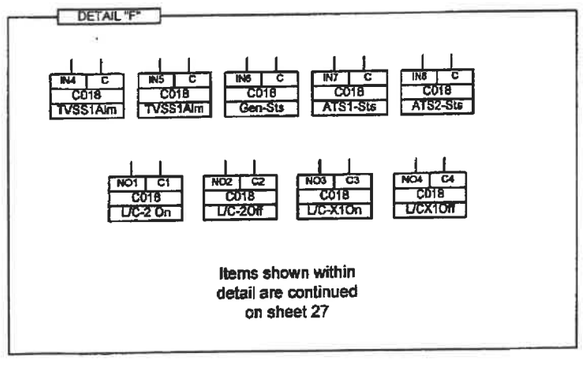


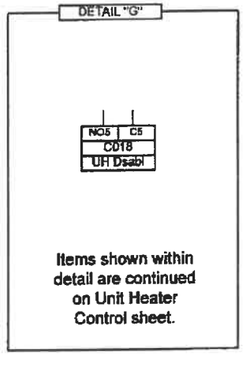


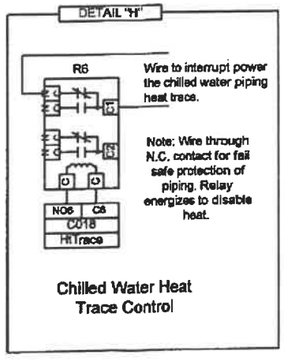


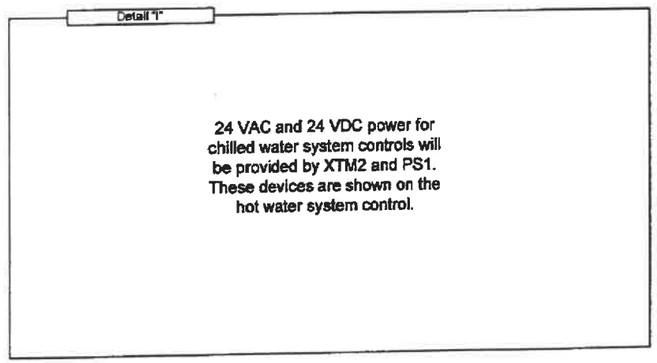












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Revisions

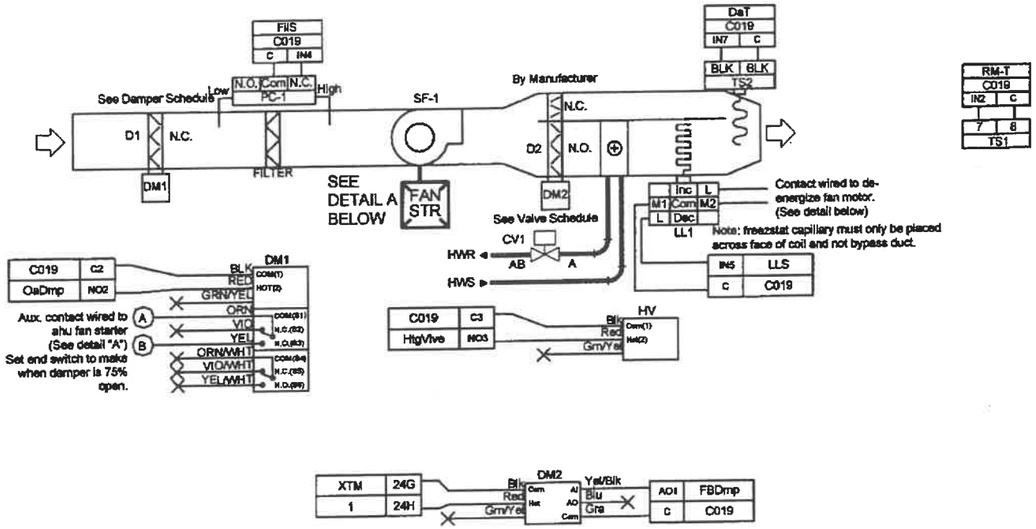
#	Change:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

Ch W System Control (Part 2)

Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

JOB NUMBER PRCC04032
FILE NAME CHWSYS.vsd
SHEET NO. 24 OF 39



Boiler MAU Device	Qty	Part Number	Description	Vendor
C019	1	MNL-800-101	MNL800 LONMARK CONTROLLER-CIRC	INVENSYS BLDG SYSTEMS
C019_1	1	ENCL-MZ800-WAL	ENCLOSURE FOR MZ 2 & MNL-800-W	INVENSYS BLDG SYSTEMS
CT1	1	E112-708	ADJ SETPT; TRIP LED; POWER LED	SINGLE SOURCED SOLUTIONS
DM1	1	MA40-7153-502	DIR MT DMP OPR 2 POS SR 24V 13	INVENSYS BLDG SYSTEMS
DM2	1	MS40-7153	DIR MT DMP OPR PROP SR 24V 133	INVENSYS BLDG SYSTEMS
LL1	1	KEL-A70HA-2	FREEZ STAT MAN. RESET DPDT. 35	Kele
PC-1	1	PC-301	PRESSURE CONTROL, ADJ. .05~1.	INVENSYS BLDG SYSTEMS
TS1	1	TS-5711-850	1A MN SNSR-ROOM,CLASSIC COVER	INVENSYS BLDG SYSTEMS
TS2	1	TS-8405	5' AVG. SENSOR 1 K OHM BALCO	SINGLE SOURCED SOLUTIONS
XTM1	1	T-201-1	TRANSFORMER 50 VA, 120V-P, 24V	SINGLE SOURCED SOLUTIONS
XTM1_1	1	SSU	LIGHTED FUSED SWITCH	SINGLE SOURCED SOLUTIONS

SEQUENCE OF OPERATION

Supply Fan (SF-1)

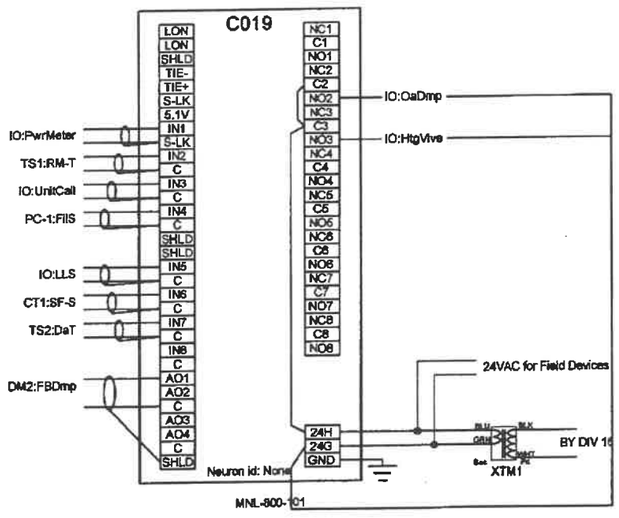
The boiler room supply fan will be interlocked to run whenever any boiler is activated. In addition, the fan will run whenever the wall-mounted space temperature sensor's cooling or heating setpoint mandates.

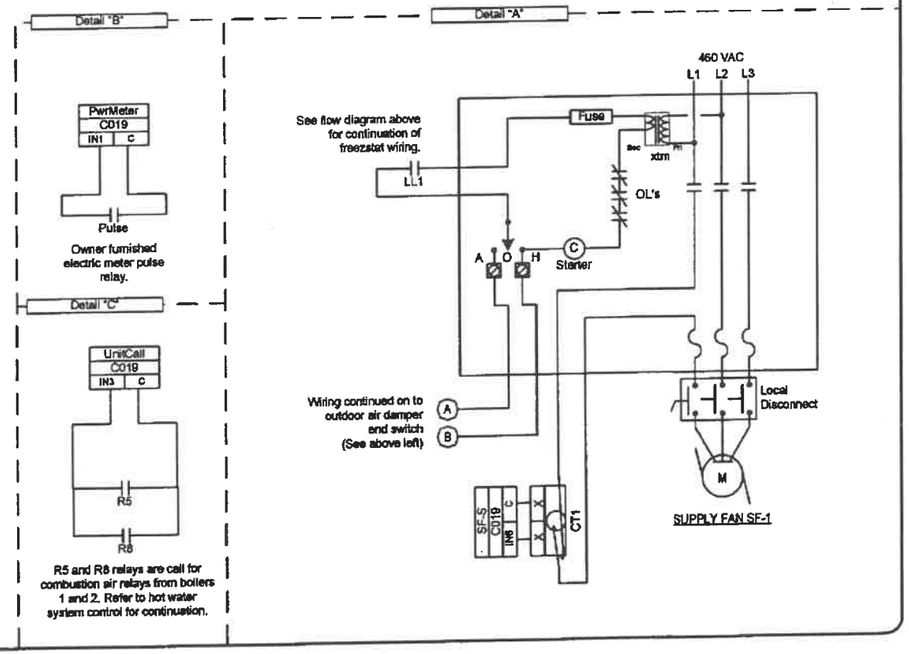
Integral Face and Bypass Damper and Hot Water Coil(IFB-1)

The IFB heating valve will open whenever the wall-mounted space temperature sensor calls for heat or whenever the discharge air temperature sensor call for heat.

The damper will open to the coil on a call for space or discharge air heat and will close to the coil when space or discharge air temperature setpoint is satisfied.

The discharge air temperature sensor will be set for 55°F but will be reset up as required to maintain space temperature.





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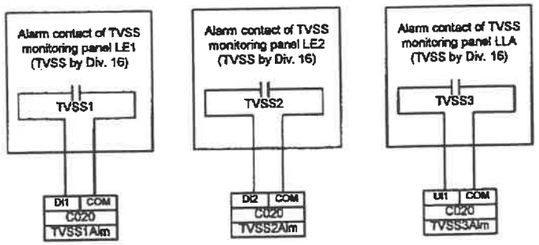
#	Change:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

JOB NUMBER PRCC04032
FILE NAME BOILER MAU.vwd
SHEET NO. 25 OF 39

Sup.Fan SF-1 and IFB-1 Contrl

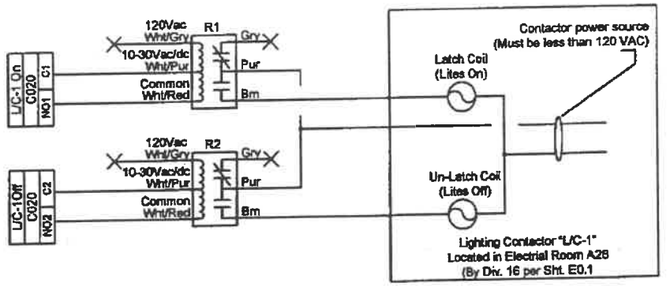
Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

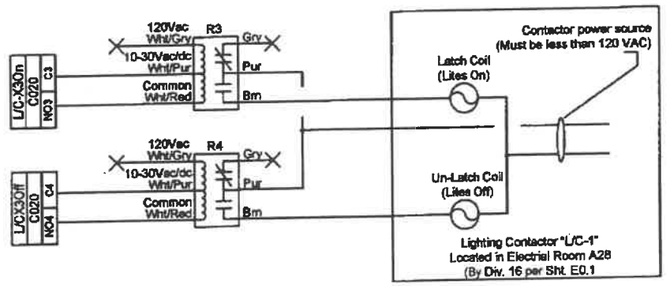


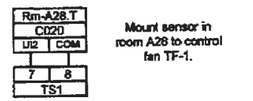
Sequence of Operation:

Lighting Contactors: The lighting contactors will be provided under Division 16 and controlled by the DDC. At a preprogrammed time each day, the DDC will energize the lighting contactors. At the end of the programmed time, the DDC will de-energize the lighting contactors.

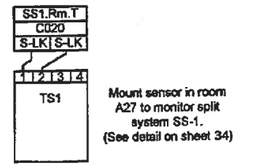
Transfer Fans: Transfer fan will be operated by thermostats control of the DDC. The DDC will monitor the fan status.



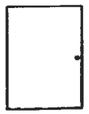


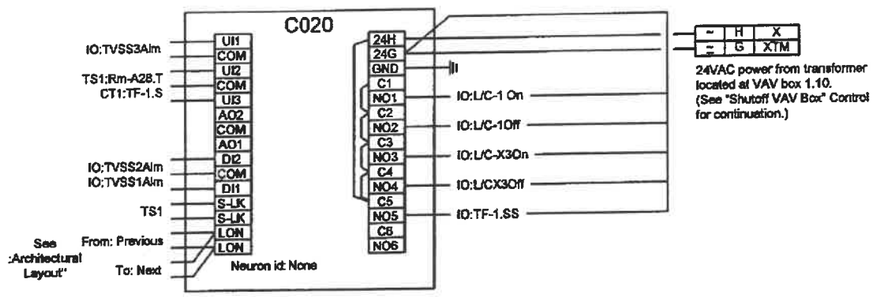


Mount sensor in room A28 to control fan TF-1.

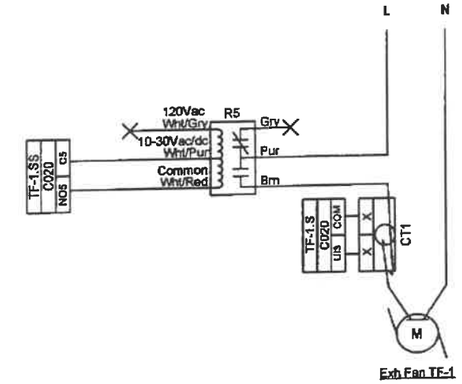


Mount sensor in room A27 to monitor split system SS-1. (See detail on sheet 34)





24VAC power from transformer located at VAV box 1.10. (See "Shutoff VAV Box" Control for continuation.)



-- Exh. Fan TF-1 Control --

Misc Points (Room A28)

Device	Qty	Part Number	Description	Vendor
CD20	1	MNL-20RS3	MN 200 CONT. WITH LONMARK ROOF	INVENSYS BLDG SYSTEMS
CT1	1	E112-800	CURRENT SWITCH; .5-200A; N.O.	SINGLE SOURCED SOLUTIONS
ENCL1	1	KEL-HC18126P	18x12x6 Nema 1 Enclosure w/Sub	Kele and Associates
R1-5	5	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
TS1	1	TS-5711-850	IA MN SNSR-ROOM,CLASSIC COVER	INVENSYS BLDG SYSTEMS

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Addn and Renov. to Booker T. Washington M.S.
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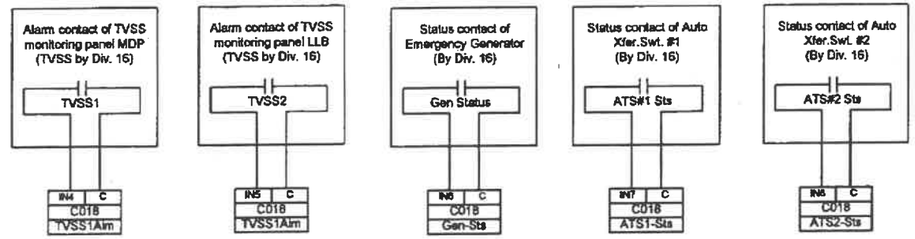
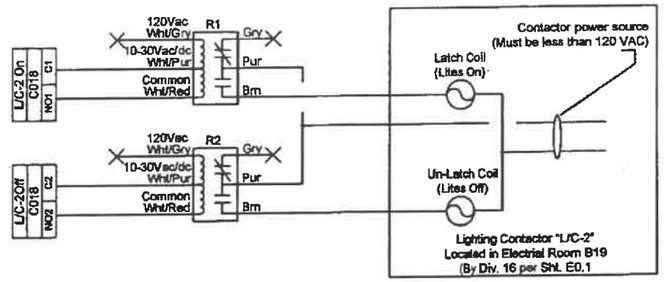
Newport News, Virginia

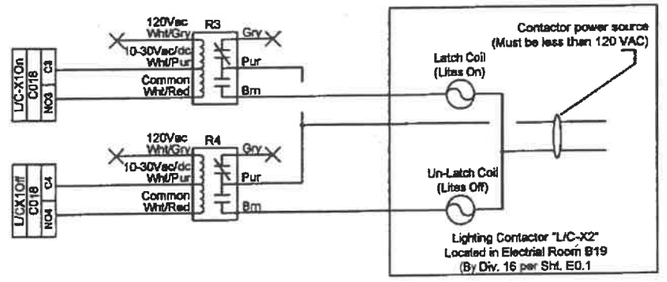
Misc. Points (Rm A28)

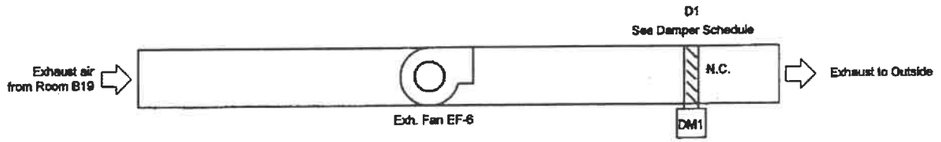
Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

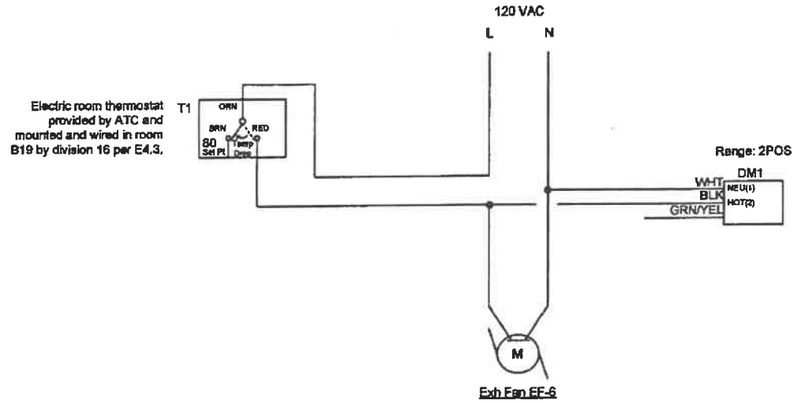
JOB NUMBER PRCC04032
FILE NAME MiscPoints.vsd
SHEET NO. 26 OF 39











-- Exh. Fan EF-6 Control --

Sequence of Operation:

Lighting Contactors: The lighting contactors will be provided under Division 16 and controlled by the DDC. At a preprogrammed time each day, the DDC will energize the lighting contactors. At the end of the programmed time, the DDC will de-energize the lighting contactors.

Service Entrance Surge Supression Devices:

The DDC Controller will monitor the service entrance surge suppression devices (provided by Division 16). If the device goes into alarm, it will send an alarm to the host work station.

Distribution Panels Surge Suppresion Devices:

The DDC Controller will monitor the distribution panels surge suppression devices (provided by Division 16), see electrical drawings for quantity and location. If the device goes into alarm, it will send an alarm to the host workstation

Misc Points (Room B19)

Device	Qty	Part Number	Description	Vendor
DM1	1	MA40-7040	DIR MT DMP OPR 2 POS SR 120V 3	INVENSYS BLDG SYSTEMS
R1-4	4	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
T1	1	TC-1103	ROOM STAT SPDT, 75-105F(INCL I	INVENSYS BLDG SYSTEMS

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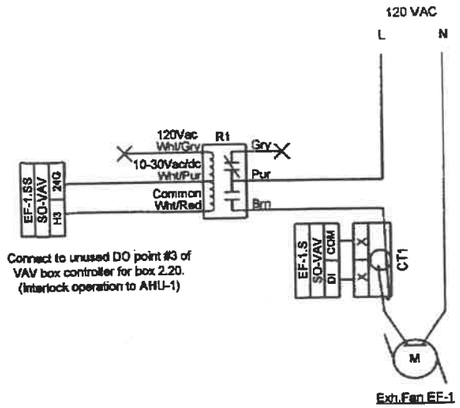
Revisions

#	Change:	Date:

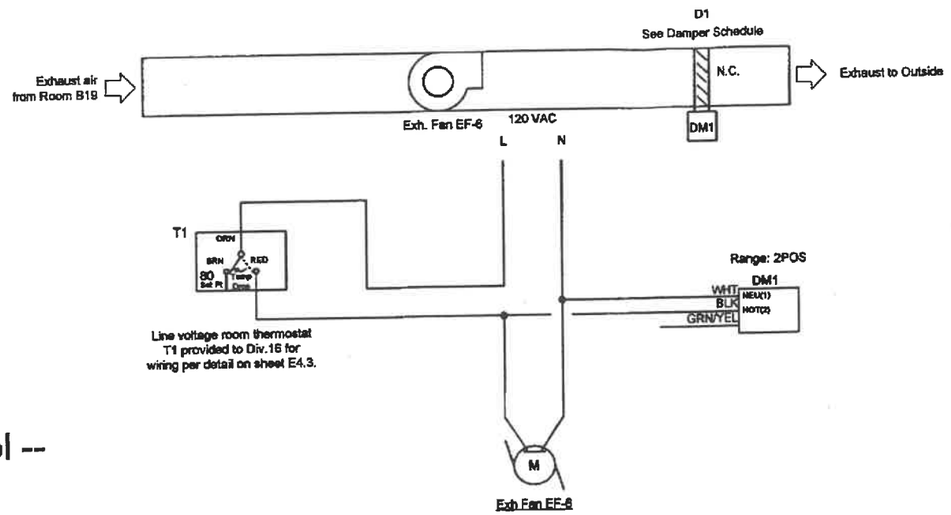
Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia
Misc. Points (Rm B19)

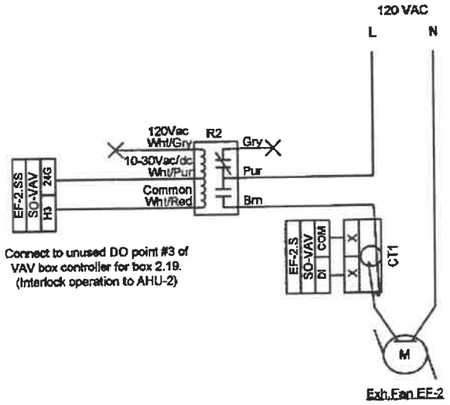
JOB NUMBER PRCC04032
FILE NAME MiscPointe.vwd
SHEET NO. 27 OF 39



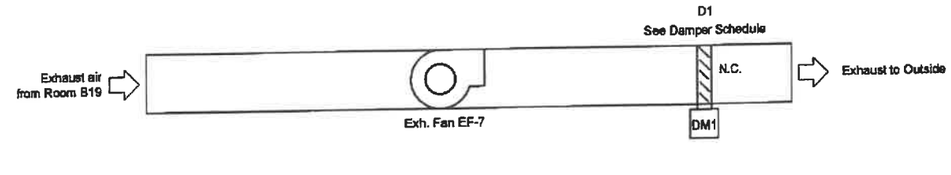
-- Exh. Fan EF-1 Control --

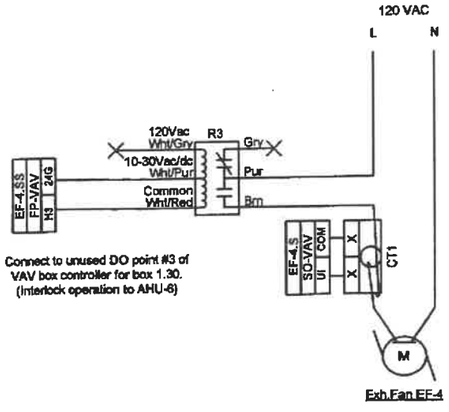


-- Exh. Fan EF-6 Control --

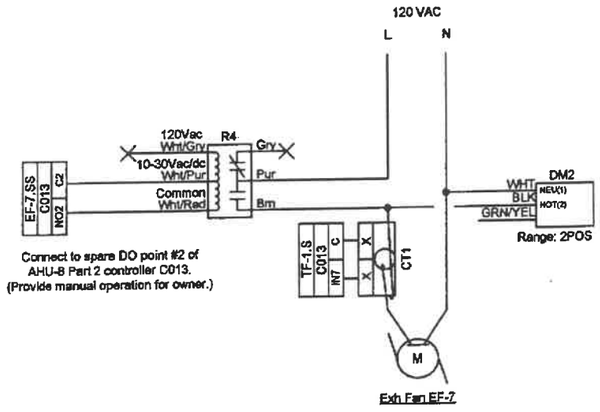


-- Exh. Fan EF-2 Control --





-- Exh. Fan EF-4 Control --



-- Exh. Fan EF-7 Control --

SEQUENCE OF OPERATTION

General Exhaust Fans: Unless otherwise indicated on the exhaust fan schedule, exhaust fans will be enabled/disabled through the DDC in conjunction with their associated air handler units, or heating and ventilating units. In addition, the DDC will monitor fan status utilizing current relay sensors.

Electrical Room Exhaust Fan: The electrical room exhaust fan will run whenever the setpoint of the wall-mounted space temperature sensor is exceeded. Interlock with control damper to open damper when fan starts.

Misc Points (EF-1) Device	Qty	Part Number	Description	Vendor
CT1	1	E112-708	ADJ SETPT; TRIP LED; POWER LED	SINGLE SOURCED SOLUTIONS
R1	1	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS

Misc Points (EF-2) Device	Qty	Part Number	Description	Vendor
CT1	1	E112-800	CURRENT SWITCH; .5-200A; N.O.	SINGLE SOURCED SOLUTIONS
R2	1	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS

Misc Points (EF-4) Device	Qty	Part Number	Description	Vendor
CT1	1	E112-800	CURRENT SWITCH; .5-200A; N.O.	SINGLE SOURCED SOLUTIONS
R3	1	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS

Misc Points (EF-6) Device	Qty	Part Number	Description	Vendor
DM1	1	MA40-7040	DIR MT DMP OPR 2 POS SR 120V 3	INVENSYS BLDG SYSTEMS
T1	1	TC-1103	ROOM STAT SPDT, 75-105F(INCL I	INVENSYS BLDG SYSTEMS

Misc Points (EF-7) Device	Qty	Part Number	Description	Vendor
CT1	1	E112-708	ADJ SETPT; TRIP LED; POWER LED	SINGLE SOURCED SOLUTIONS
DM2	1	MA40-7040	DIR MT DMP OPR 2 POS SR 120V 3	INVENSYS BLDG SYSTEMS
R4	1	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS

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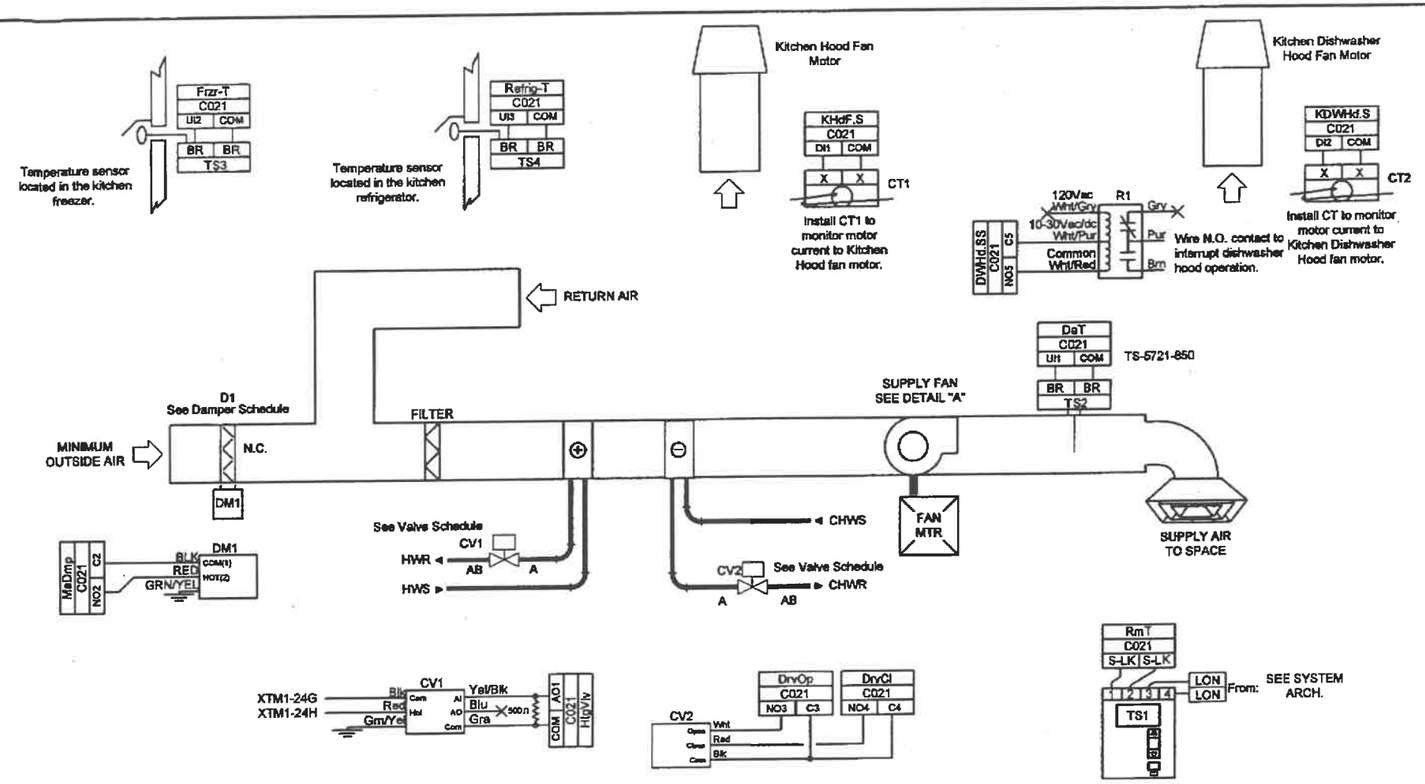
Revisions

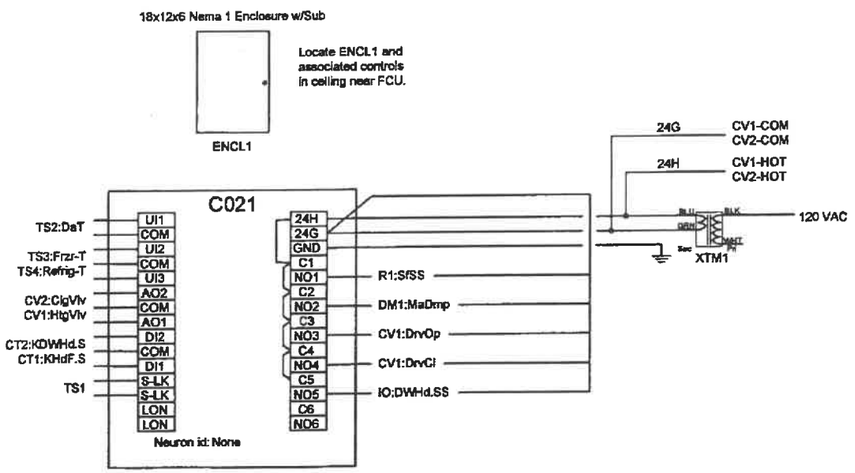
#:	Change:	Date:

RRMM Architects
Matthew J. Thompson
Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia
Misc. Fans Control

JOB NUMBER PRCC04032
FILE NAME MiscPoints.vsd
SHEET NO. 28 OF 39





SEQUENCE OF OPERATION

Fan-Coil Unit:

On a fall in space temperature below setpoint, the DDC will modulate the heating coil (preheat position) control valve fully open. On a rise in space temperature, the DDC will modulate the heating coil control valve closed. On a further rise in the space temperature above setpoint (adj.), the DDC will modulate the chilled water control valve fully open. On a fall in space temperature, the reverse will occur.

The discharge air temperature sensor will act to override the space temperature sensor and maintain a minimum discharge air temperature if required.

KITCHEN HOOD FANS

The kitchen hood fans will be controlled from its integral control panel. Fan status will be monitored by current sensor relays.

DISHWASHER EXHAUST FAN

Dishwasher exhaust fan will be interlocked to run by wall-mounted switch. In addition, the fan will be controlled from the Kitchen occupancy schedule to run in the occupied mode and to shut down in the unoccupied mode

Dishwaser Hood Control

Device	Qty	Part Number	Description	Manufacturer
CT2	1	E112-708	ADJ SETPT; TRIP LED; POWER LED	VERIS
R1	1	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	LECTRO / IDEC

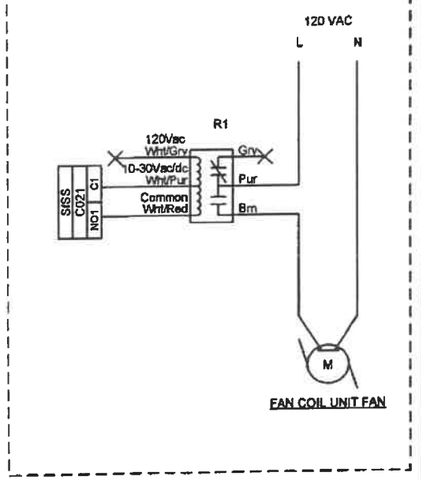
Fan Coil Unit Control

Device	Qty	Part Number	Description	Manufacturer
C021	1	MNL-2DRS3	MN 200 CONT. WITH LONMARK ROOF	INVENSYS- AUTOMATION
DM1	1	MA40-7043	DIR MT DMP OPR 2 POS SR 24V 35	INVENSYS- COMPONENTS
ENCL1	1	KEL-HC18126P	18x12x6 Nema 1 Enclosure w/Sub	Hoffman
R1	1	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	LECTRO / IDEC
TS1	1	MN-S3	IA MICRONET S-LINK SENSOR W/OV	INVENSYS- AUTOMATION
TS2	1	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER	INVENSYS- AUTOMATION
TS3-4	2	TS-5751-850	IA MICRONET SENSOR- OUTSIDE A	INVENSYS- AUTOMATION
XTM1	1	T-201-1	TRANSFORMER 50 VA, 120V-P, 24V	CORE

Kitchen Hood Control

Device	Qty	Part Number	Description	Manufacturer
CT1	1	E112-708	ADJ SETPT; TRIP LED; POWER LED	VERIS

DETAIL "A"



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Revisions

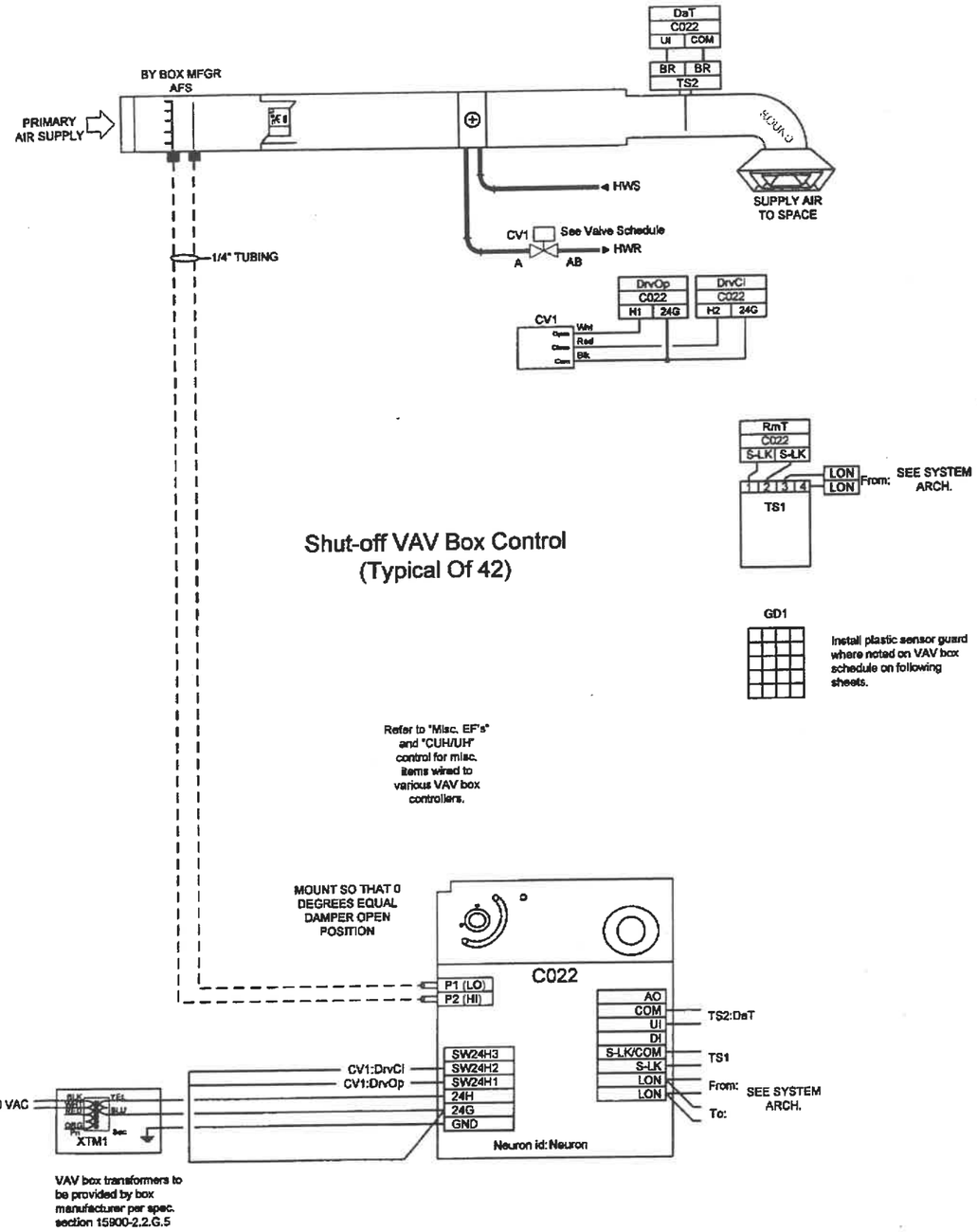
#	Change:	Date:

Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

Fan Coil Unit Control

JOB NUMBER PRCC04032
FILE NAME FCU.vsd
SHEET NO. 29 OF 39



Shut-off VAV Box Control (Typical Of 42)

Shut-off VAV Box Control Device	Qty	Part Number	Description	Manufacturer
C022	42	MNL-V2RV2	LONMARK CONTR. FAN PWRD VAV/RE	INVENSYS- AUTOMATION
GD1	10	AT-1104	TSTAT GUARD, CAST FOR SINGLE S	INVENSYS- COMPONENTS
TS1	42	MN-S1	IA MICRONET S-LINK SENSOR	INVENSYS- AUTOMATION
TS2	42	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER	INVENSYS- AUTOMATION

SEQUENCE OF OPERATION

VAV TERMINAL UNITS

Shut-off VAV Box Control: On a fall in space temperature as sensed through the DDC Controller, the DDC Controller will modulate the primary air valve closed to maintain minimum airflow. On a further fall in space temperature as sensed the DDC Controller, the DDC Controller will modulate the HW valve to maintain space temperature. On a rise in space temperature, the HW valve will modulate closed. On a further rise in space temperature, the DDC Controller will modulate the primary valve open. The DDC Controller will monitor discharge temperature in each box.

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Revisions

#	Change:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

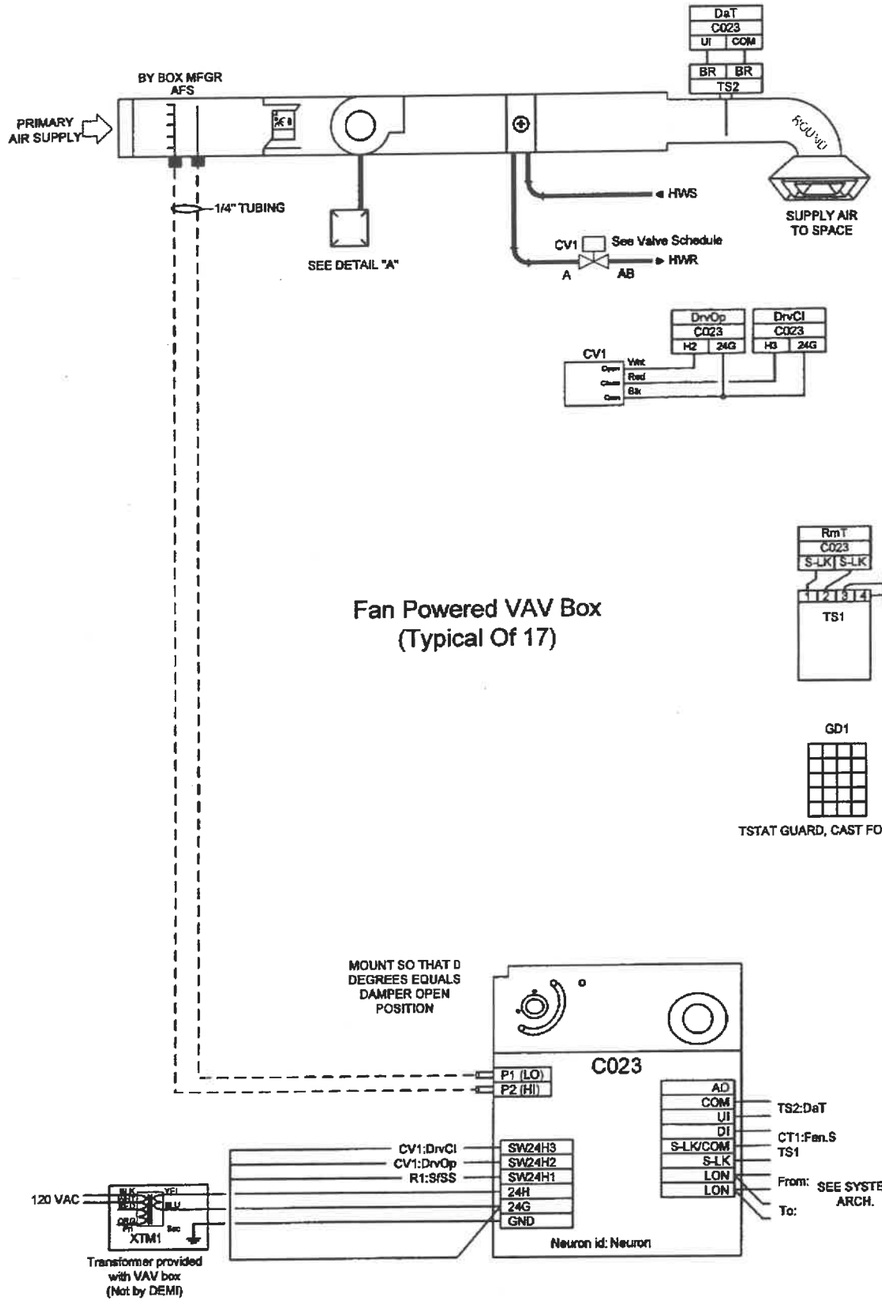
Shut-off Type VAV Box Control

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

JOB NUMBER PRCC04032

FILE NAME VAV Shutoff.vwd

SHEET NO. 30 OF 39



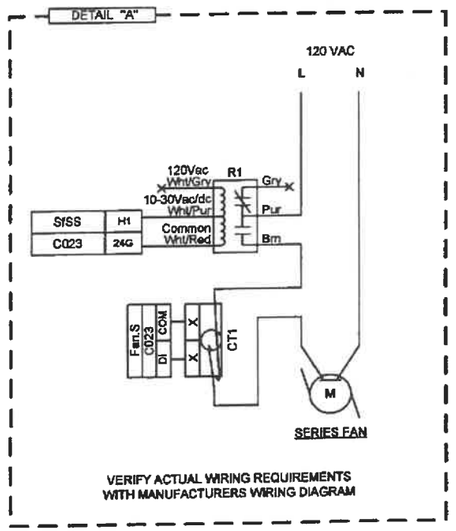
Fan Powered VAV Box
(Typical Of 17)

Fan Powered VAV Box Device	Qty	Part Number	Description	Manufacturer
CD01	17	MNL-V2RV2	LONMARK CONTR. FAN PWRD VAV/RE	INVENSYS- AUTOMATION
CT1	17	E112-800	CURRENT SWITCH; .5-200A; N.O.	VERIS
GD1	4	AT-1104	TSTAT GUARD, CAST FOR SINGLE S	INVENSYS- COMPONENTS
R1	17	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	LECTRO / IDEC
TS1	17	MN-S1	IA MICRONET S-LINK SENSOR	INVENSYS- AUTOMATION
TS2	17	TS-5721-850	IA MICRONET SENSOR- DUCT/IMMER	INVENSYS- AUTOMATION

SEQUENCE OF OPERATION

VAV TERMINAL UNITS

Fan Powered: The DDC will energize the fan in occupied mode. On a fall in space temperature as sensed through the DDC Controller, the DDC Controller will modulate the primary air valve closed to maintain minimum airflow. On a further fall in space temperature as sensed by the DDC Controller, the DDC Controller will modulate the HW valve to maintain space temperature. On a rise in space temperature, the HW valve will modulate closed. On a further rise in space temperature, the DDC Controller will modulate the primary valve open. The DDC Controller will maintain minimum CFM and monitor discharge temperature in each box. In unoccupied mode, the DDC will de-energize the fan and cycle the fan only to maintain space night setback temperature setpoint.



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Revisions

#	Change:	Date:

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia
Fan Powered VAV Box Control

JOB NUMBER PRCC04032
FILE NAME VAV FP.vsd
SHEET NO. 31 OF 39

VAV Box Schedule

No.	Box Tag	Rooms Served	Sensor Location	Inlet Size	Flow Cal. @ 1" W.C.	Primary CFM		Box Type	Box Fan		Box Reheat			Served by AHU	Sensor Type
						Min. Flow	Max. Flow		Fan Type	Fan S.P.	Type	No of Stages	Min. Flow S.P.		
1	VAV 1.01	B33	B33 (G)	8		200	400	SO	none	n/a	H.W.	n/a		AHU-1	
2	VAV 1.02	A38,A39,A40	A38	10		310	950	SO	none	n/a	H.W.	n/a		AHU-1	
3	VAV 1.03	A35,A36	A36	8		190	620	SO	none	n/a	H.W.	n/a		AHU-1	
4	VAV 1.04	A41	A41	12		315	1040	SO	none	n/a	H.W.	n/a		AHU-1	
5	VAV 1.05	A42	A42 (G)	10		275	550	SO	none	n/a	H.W.	n/a		AHU-1	
6	VAV 1.06	A53	A53	12		365	1220	SO	none	n/a	H.W.	n/a		AHU-1	
7	VAV 1.07	A53	A53	12		365	1220	SO	none	n/a	H.W.	n/a		AHU-1	
8	VAV 1.08	A55,A02,A14	A55 (G)	12		500	1000	SO	none	n/a	H.W.	n/a		AHU-1	
9	VAV 1.09	A54	A54	6		140	270	SO	none	n/a	H.W.	n/a		AHU-1	
10	VAV 1.10	A04,A09	A04	12		370	1240	F	Series	n/a	H.W.	n/a		AHU-1	
11	VAV 1.11	A04,A05,A06,A08	A08	6		105	340	F	Series	n/a	H.W.	n/a		AHU-1	
12	VAV 1.12	A13	A13	8		135	430	F	Series	n/a	H.W.	n/a		AHU-1	
13	VAV 1.13	A17.2,A18	A18	8		175	580	F	Series	n/a	H.W.	n/a		AHU-1	
14	VAV 1.14	A26	A26	12		315	1050	SO	none	n/a	H.W.	n/a		AHU-1	
15	VAV 1.15	A17.1,A19,A20.1	A19	8		120	405	F	Series	n/a	H.W.	n/a		AHU-1	
16	VAV 1.16	A21	A21	12		325	1080	SO	none	n/a	H.W.	n/a		AHU-1	
17	VAV 1.17	A25,A30	A25	8		190	620	SO	none	n/a	H.W.	n/a		AHU-1	
18	VAV 1.18	A24	A24	12		335	1120	SO	none	n/a	H.W.	n/a		AHU-1	
19	VAV 1.19	A22	A22	5		135	180	SO	none	n/a	H.W.	n/a		AHU-1	
20	VAV 1.20	B01	B01	12		390	1080	SO	none	n/a	H.W.	n/a		AHU-1	
21	VAV 1.21	B02	B02	12		390	1180	SO	none	n/a	H.W.	n/a		AHU-1	
22	VAV 1.22	B05	B05	12		390	1120	SO	Series	n/a	H.W.	n/a		AHU-1	
23	VAV 1.23	B03	B03	12		390	1180	SO	none	n/a	H.W.	n/a		AHU-1	
24	VAV 1.24	Hallway	Hallway (G)	8		165	450	SO	none	n/a	H.W.	n/a		AHU-1	
25	VAV 1.25	B32	B32	10		375	900	SO	none	n/a	H.W.	n/a		AHU-1	
26	VAV 1.26	B29	B29 (G)	6		160	300	SO	none	n/a	H.W.	n/a		AHU-1	
27	VAV 1.27	B31	B31	12		405	1320	SO	none	n/a	H.W.	n/a		AHU-1	
28	VAV 1.28	B30	B30	12		405	1320	SO	none	n/a	H.W.	n/a		AHU-1	
29	VAV 1.29	B10	B10 (G)	8		145	480	F	Series	n/a	H.W.	n/a		AHU-6	
30	VAV 1.30	B10	B10 (G)	10		240	800	F	Series	n/a	H.W.	n/a		AHU-6	
31	VAV 1.31	B16	B16	10		390	900	SO	none	n/a	H.W.	n/a		AHU-6	
32	VAV 1.32	B16,B17	B17	6		95	310	F	Series	n/a	H.W.	n/a		AHU-6	
33	VAV 1.33	B15	B15	14		800	1920	SO	none	n/a	H.W.	n/a		AHU-6	
34	VAV 1.35	B13	B13	6		95	310	F	Series	n/a	H.W.	n/a		AHU-6	
35	VAV 1.36	B20	B20	6		90	300	F	Series	n/a	H.W.	n/a		AHU-6	
36	VAV 1.37	A32	A32	6		85	280	F	Series	n/a	H.W.	n/a		AHU-1	
37	VAV 1.38	B11,B12,B14	B14	6		85	280	F	Series	n/a	H.W.	n/a		AHU-6	
38	VAV 2.01	207,208,209	207	8		175	580	F	Series	n/a	H.W.	n/a		AHU-6	
39	VAV 2.02	205	205	12		390	1240	SO	none	n/a	H.W.	n/a		AHU-2	
40	VAV 2.03	211	211	12		390	1240	SO	none	n/a	H.W.	n/a		AHU-2	
41	VAV 2.04	204	204	12		390	1240	SO	none	n/a	H.W.	n/a		AHU-2	
42	VAV 2.05	212	212	12		390	1240	SO	none	n/a	H.W.	n/a		AHU-2	
43	VAV 2.06	Hallway	Hallway (G)	8		195	450	SO	none	n/a	H.W.	n/a		AHU-2	
44	VAV 2.07	203	203	6		90	295	F	Series	n/a	H.W.	n/a		AHU-2	
45	VAV 2.08	202	202	12		390	1220	SO	none	n/a	H.W.	n/a		AHU-2	
46	VAV 2.09	201	201	12		390	1180	SO	none	n/a	H.W.	n/a		AHU-2	

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Revisions

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Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical
Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

VAV Box Schedule (Part 1)

JOB NUMBER PRCC04032
FILE NAME VAVSched.vwd
SHEET NO. 32 OF 39

VAV Box Schedule

No.	Box Tag	Rooms Served	Sensor Location	Inlet Size	Flow Cal. @ 1" W.C.	Primary CFM		Box Type	Box Fan		Box Reheat			Served by AHU	Sensor Type
						Min. Flow	Max. Flow		Fan Type	Fan S.P.	Type	No of Stages	Min. Flow S.P.		
47	VAV 2.10	234	234	14		520	1680	SO	none	n/a	H.W.	n/a		AHU-2	
48	VAV 2.11	233	233	12		390	1350	SO	none	n/a	H.W.	n/a		AHU-2	
49	VAV 2.12	231	231 (G)	6		140	300	SO	none	n/a	H.W.	n/a		AHU-2	
50	VAV 2.13	232	232	12		390	1350	SO	none	n/a	H.W.	n/a		AHU-2	
51	VAV 2.14	216	216	6		85	280	F	Series	n/a	H.W.	n/a		AHU-2	
52	VAV 2.15	217	217	10		285	860	SO	none	n/a	H.W.	n/a		AHU-2	
53	VAV 2.16	230	230	12		390	1350	SO	none	n/a	H.W.	n/a		AHU-2	
54	VAV 2.17	229	229	12		390	1410	SO	none	n/a	H.W.	n/a		AHU-2	
55	VAV 2.18	224	224	12		390	1240	SO	none	n/a	H.W.	n/a		AHU-2	
56	VAV 2.19	225	225 (G)	12		390	1240	SO	none	n/a	H.W.	n/a		AHU-2	
57	VAV 2.20	2217,218,219	217	12		385	1070	SO	none	n/a	H.W.	n/a		AHU-2	
58	VAV 2.22	220,225	225 (G)	6		85	280	F	Series	n/a	H.W.	n/a		AHU-2	
59	VAV 2.23	227	227 (G)	6		85	280	F	Series	n/a	H.W.	n/a		AHU-2	
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Dominion Energy Management Inc.
11250-B Hopson Road
Ashland, Virginia 23005
Phone 804.798.3189
Fax 804.798.3878
Authorized Invensys Representitive

Revisions

#	Change:	Date:

Architect: RRMM Architects
Engineer: Matthew J. Thompson
Contractor: Tidewater Mechanical

Designed by: SBP Date: 3/14/05
Software by: Date:
Checked by: Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

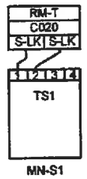
VAV Box Schedule (Part 2)

JOB NUMBER PRCC04032
FILE NAME VAVSched.vxd
SHEET NO. 33 OF 39

Manufacturers data indicates that "double insulated, 3-wire 18 gauge cable is mandatory or use shielded three wire cable" between the indoor unit and the outdoor unit.

Ductless "Split System (SS-1)" Interlock Wiring

(Typical as noted for SS-2 and SS-3)



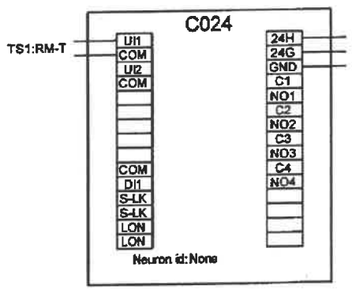
Split system #1 space temperature sensor (Locate in room A27)

Sensor connected via S-LNK to controller C020. (See sheet

Split system #2 space temperature sensor (Locate in room 215)

Connected to controller C004 input point #IN5.

Split system #3 space temperature sensor (Locate in room B08)



24 VAC power from VAV box transformer located at VAV-1.30 (See VAV box control for continuation.)

Split Systems Device	Qty	Part Number	Description	Vendor
C024	1	MNL-10RS3	MN 100 LONMARK CONT./LONMARK R	INVENSYS BLDG SYSTEMS
C024_1	1	ENCL-100	GENERAL PURPOSE ENCLOSURE DIME	INVENSYS BLDG SYSTEMS
TS1	1	MN-S1	IA MICRONET S-LINK SENSOR	INVENSYS BLDG SYSTEMS
TS2-3	2	TS-5711-850	IA MN SNSR-ROOM,CLASSIC COVER	INVENSYS BLDG SYSTEMS

Sequence of Operation

Ductless Split-system Units

The units will be provided with factory mounted controls and will not be controlled by the DDC. The DDC system will monitor the space temperature in the area(s) served for monitoring and alarming.

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Revisions

#	Change:	Date:

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechankcal
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

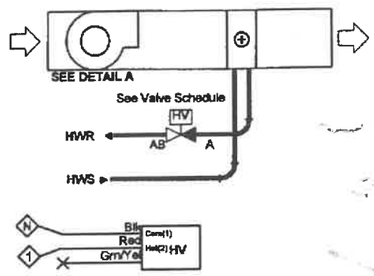
Split System Monitoring

JOB NUMBER PRCC04032

FILE NAME SplitSys.vwd

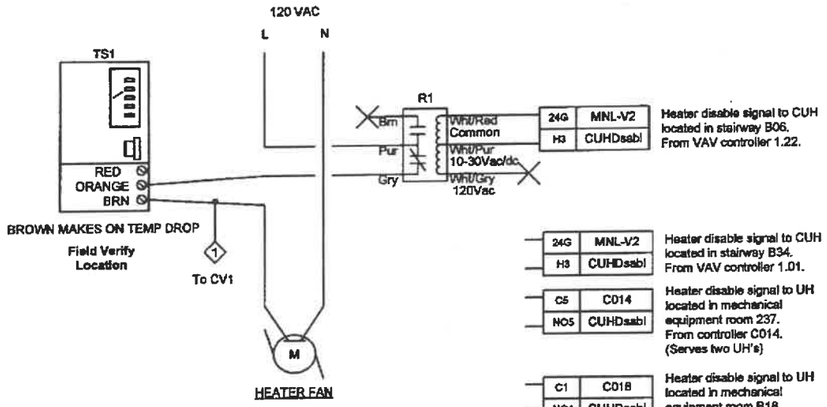
SHEET NO. 34 OF 39

Typical of 6 Unit Heaters
UH-1, UH-2, UH-3, UH-4, UH-5, UH-6



DETAIL A

Typical for all Unit Heaters and Cabinet Unit Heaters
UH-1, UH-2, UH-3, UH-4, UH-5, UH-6



Unit Heaters Device	Qty	Part Number	Description	Vendor
R1	6	CVR-11C	RIB SPDT FRM 1C 10A@277 VAC 10	SINGLE SOURCED SOLUTIONS
TS1	6	TC-1102	ROOM STAT SPDT 45-75F W/INSERT	INVENSYS BLDG SYSTEMS

SEQUENCE OF OPERATION

Unit Heaters and Cabinet Unit Heaters:

Unit heaters will be controlled by wall-mounted thermostats. On a fall in space temperature below setpoint, the heating water control valve will fully open, and the fan will be started. The DDC will provide a DO point(s) for disabling all fans for unit heaters and cabinet unit heaters.

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Revisions

#	Change:	Date:

Architect:	RRMM Architects
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical
Designed by:	SBP Date: 3/14/05
Software by:	Date:
Checked by:	Date:

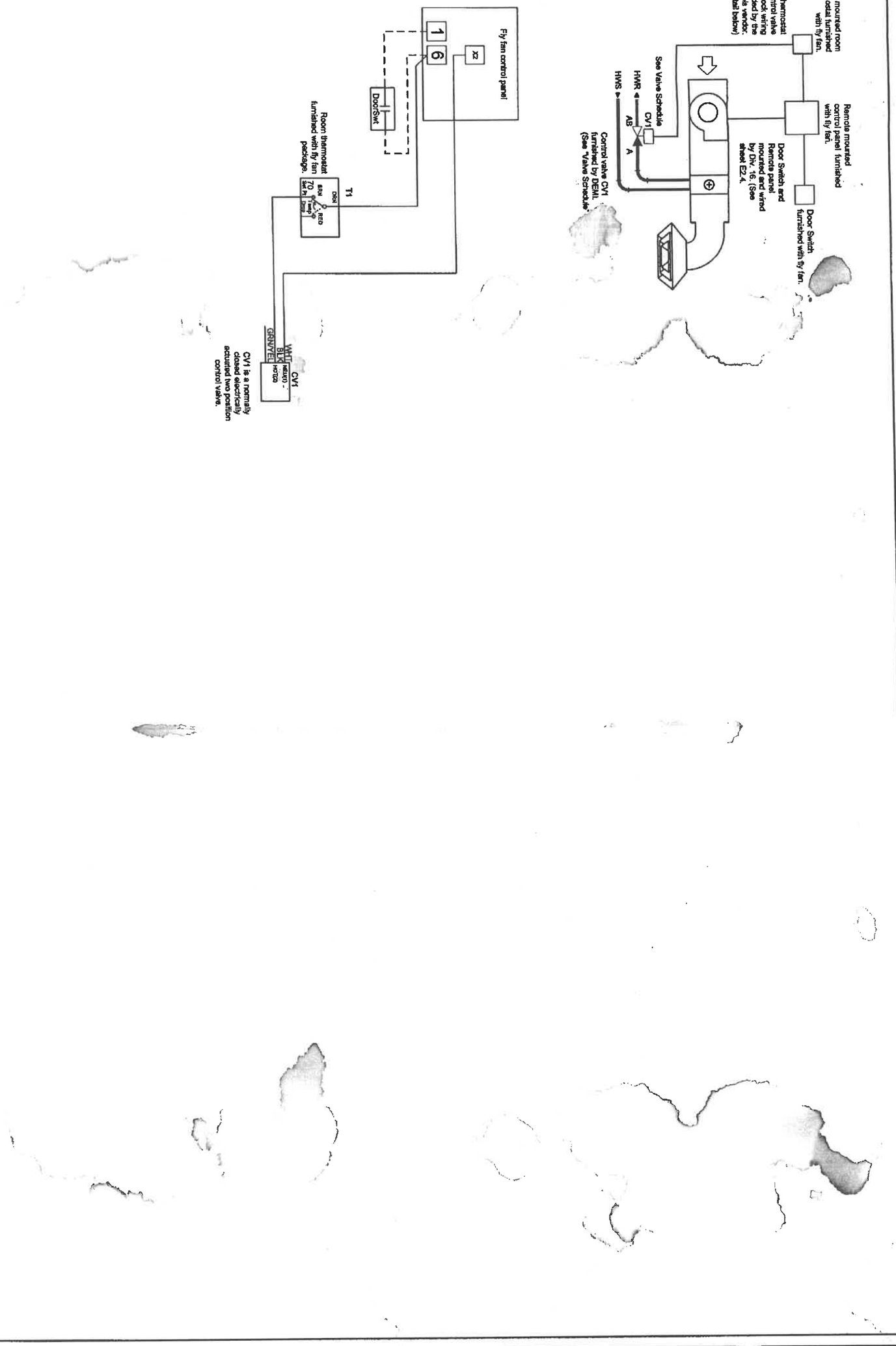
JOB NUMBER PRCC04032

FILE NAME Unit Heaters.vsd

Addn and Renov. to Booker T. Washington M.S.
Chesnut Avenue
Newport News, Virginia

SHEET NO. 35 OF 39

CUH/UH Control



JOB NUMBER PRCC04032	Addn and Renov. to Booker T. Washington M.S.	Architect:	RRMM Architects
FILE NAME FlyFan.vsd	Chesnut Avenue	Engineer:	Matthew J. Thompson
	Newport News, Virginia	Contractor:	Tidewater Mechanical
SHEET NO. 36 OF 39	Kitchen Fly Fan Control	Designed by: SBP	Date: 3/14/05
		Software by:	Date:
		Checked by:	Date:

Revisions		
#	Change:	Date:

Dominion Energy Management Inc.
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Company:	Dominion Energy Management Inc.
	11250-B Hopson Road
	Ashland, Virginia 23005
Phone:	804-798-3189
Fax:	804-798-3878

Project Name:	Additions and Renovations to Booker T. Middle School
Project Number:	PRCC04032
Owner:	Newport News Schools
Engineer:	Mattew J. Thompson
Contractor:	Tidewater Mechanical

Sheet:	37 of 39
Date:	3/7/2005
Revision:	Initial

VALVE PRESSURE DROP (PSI) TO BE USED IN H_2O CALCULATIONS: 3.0

STEAM INLET PRESSURE (PSIG) TO BE USED IN STEAM APPLICATIONS: 5.0

AUTOMATIC TEMPERATURE CONTROL VALVE SCHEDULE (PLEASE SEE INSTALLATION NOTES)

ITEM	LOCATION	TAG	QTY	SERVICE	PART # VALVE ASSEMBLY	ACTUATOR	SPRING RANGE	POS. POSIT.	VLV. TYPE	VLV. SIZE	PIPE SIZE	VLV. ACTION	CONN. TYPE	FLOW GPM	VALVE CV #/HR	VALVE CV CALC.	VALVE CV ACT.	ACT. PRESS. DROP (PSI)	CLOSE OFF (PSI) STEM UP	CLOSE OFF (PSI) STEM DN.	PIPING DETAIL
1	AHU-1 Preheat	CV1	1	HW	VS-7313-814-4-08	MS51-7103-160	PROPORTIONAL	N	3 Way Mixing	1"	1-1/4"	Fails Flow B-AB	Screwed	14.00		8.08	14.0	1.00	90	90	
2	AHU-1 Cooling	CV2	1	CW	VS-8303-596-5-12	MS61-7203	2-10 VDC/4-2	N	3 Way Mixing	2.5	3"	Fails Flow B-AB	Flanged	93.50		53.98	80.0	1.37	35	35	
3	AHU-2 Preheat	CV1	1	HW	VS-7313-814-4-08	MS51-7103-160	PROPORTIONAL	N	3 Way Mixing	1"	1-1/4"	Fails Flow B-AB	Screwed	13.50		7.79	14.0	0.93	90	90	
4	AHU-2 Cooling	CV2	1	CW	VS-8223-596-5-12	MS61-7203	PROPORTIONAL	N	2 Way N.C.	2.5	3"	Fails Flow B-AB	Flanged	98.00		56.58	56.0	3.06	35	35	
5	RAHU-3 Preheat	CV1	1	HW	VS-7213-814-4-07	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	1"	1-1/4"	Fails N.O.	Screwed	13.50		7.79	10.0	1.82	150	150	
6	RAHU-3 Cooling	CV2	1	CW	VS-7223-593-4-11	MS51-7203	PROPORTIONAL	N	2 Way Straight	2"	2-1/2"	Fails N.C.	Screwed	49.50		28.56	40.0	1.53	65	65	
7	RAHU-3 Reheat	CV3	1	HW	VS-7213-814-4-06	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	3/4"	1-1/4"	Fails N.O.	Screwed	11.50		6.64	7.5	2.35	200	200	
8	RAHU-4 Preheat	CV1	1	HW	VS-7213-814-4-04	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	1/2"	1"	Fails N.O.	Screwed	4.00		2.31	4.4	0.83	250	250	
9	RAHU-4 Cooling	CV2	1	CW	VS-7213-814-4-06	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	3/4"	1-1/4"	Fails N.O.	Screwed	13.00		7.51	7.5	3.00	200	200	
10	AHU-5 Heating(DHC-1)	CV1	1	HW	VS-7213-814-4-03	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	1/2"	3/4"	Fails N.O.	Screwed	2.50		1.44	2.2	1.29	250	250	
11	AHU-6 Preheat	CV1	1	HW	VS-7313-814-4-02	MS51-7103-160	PROPORTIONAL	N	3 Way Mixing	1/2"	1"	Fails Open to Bottom	Screwed	3.50		2.02	2.2	2.53	250	250	
12	AHU-6 Cooling	CV2	1	CW	VS-7223-814-4-08	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	1"	1-1/2"	Fails N.C.	Screwed	22.00		12.70	14.0	2.47	150	150	
13	AHU-7 Cooling	CV2	1	CW	VS-7223-814-4-09	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	1-1/4"	2"	Fails N.C.	Screwed	31.50		18.19	20.0	2.48	90	90	
14	AHU-7 Heating	CV1	1	HW	VS-7213-814-4-06	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	3/4"	1-1/4"	Fails N.O.	Screwed	12.10		6.99	7.5	2.60	200	200	
15	AHU-8 Preheat	CV1	1	HW	VS-7313-814-4-08	MS51-7103-160	PROPORTIONAL	N	3 Way Mixing	1"	1-1/2"	Fails Open to Bottom	Screwed	15.00		8.66	14.0	1.15	90	90	
16	AHU-8 Cooling	CV2	1	CW	VS-7223-593-4-11	MS51-7203	PROPORTIONAL	N	2 Way Straight	2"	3"	Fails N.C.	Screwed	52.60		30.37	40.0	1.73	65	65	
17	AHU-8 Reheat	CV3	1	HW	VS-7213-814-4-07	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	1"	1-1/4"	Fails N.O.	Screwed	13.50		7.79	10.0	1.82	150	150	
18	ERU-1 Preheat	CV1	1	HW	VS-7213-814-4-04	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	1/2"	1"	Fails N.O.	Screwed	4.40		2.54	4.4	1.00	250	250	
19	ERU-1 Cooling	CV2	1	CW	VS-7223-814-4-04	MS51-7103-160	PROPORTIONAL	N	2 Way Straight	1/2"	1"	Fails N.C.	Screwed	6.00		3.46	4.4	1.86	250	250	
20	FCU-1 Cooling	CV2	1	CW	VF-7213-255-4-04	MF-22303	FLOAT	N	2 Way Straight	1/2"	1"	No Fail Safe Position	Screwed	4.00		2.31	4.4	0.83	160	160	
21	FCU-1 Heating	CV1	1	HW	VS-7213-810-4-02	MS51-7103-140	PROPORTIONAL	N	2 Way Straight	1/2"	3/4"	Fails N.O.	Screwed	1.00		0.58	1.3	0.59	250	250	
22	Hot Water Reset	CV1	1	HW	VS-8303-596-5-13	MS61-7203	2-10 VDC/4-2	N	3 Way Diverting	3"	4"	Fails AB-B	Flanged	190.50		109.99	120.0	2.52	35	35	
23	VAV Box 1.0 GPM	CV1	56	HW	VF-7213-255-4-02	MF-22303	FLOAT	N	2 Way Straight	1/2"	3/4"	No Fail Safe Position	Screwed	1.00		0.58	1.3	0.59	160	160	
24	VAV Box 1.5 GPM	CV1	2	HW	VF-7213-255-4-02	MF-22303	FLOAT	N	2 Way Straight	1/2"	3/4"	No Fail Safe Position	Screwed	1.50		0.87	1.3	1.33	160	160	
25	VAV Box 2.0 GPM	CV1	1	HW	VF-7213-255-4-02	MF-22303	FLOAT	N	2 Way Straight	1/2"	3/4"	No Fail Safe Position	Screwed	2.00		1.15	1.3	2.37	160	160	
26	IFB-1 Heating Coil	CV1	1	HW	VA-7213-536-4-04	MA40-7043	2POS	N	2 Way Straight	1/2"	1-1/4"	Fails N.O.	Screwed	7.00		4.04	4.4	2.53	250	250	
27	Cabinet Unit Heater	CV1	2	HW	VA-7223-532-4-04	MA40-7040	2POS	N	2 Way Straight	1/2"		Fails N.C.	Screwed	1.50		0.87	4.4	0.12	250	250	
28	Horiz. Unit Heater	CV1	4	HW	VA-7223-532-4-04	MA40-7040	2POS	N	2 Way Straight	1/2"	3/4"	Fails N.C.	Screwed	3.00		1.73	4.4	0.46	250	250	
29	Fly Fan Heating Coil	CV1	1	HW	VA-7223-532-4-04	MA40-7040	2POS	N	2 Way Straight	1/2"	1"	Fails N.C.	Screwed	4.30		2.48	4.4	0.96	250	250	

A

Invensys Dominion Energy Management
11250-B Hopson Road
Ashland, Virginia 23005
Phone: 804-798-3189
Facsimile: 804-798-3878

Project Name:	Booker T. Middle School
Project Number:	PRCC04032
Owner:	Newport News Schools
Engineer:	Matthew J. Thompson
Contractor:	Tidewater Mechanical

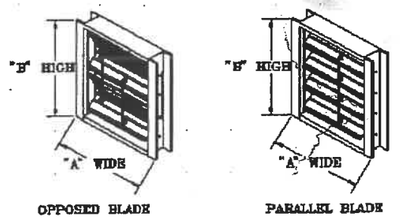
Damper Shipping Information:	
Ship to:	
Mark Shipment:	

GENERAL NOTES:
THE DAMPER MANUFACTURER WILL DEDUCT 1/4" FROM THE CONFIRMED SIZES FOR INSTALLATION CLEARANCE

SHEET METAL CONTRACTOR
SIZES ONLY HAVE TO BE CHECKED AND CONFIRMED.
PLEASE INDICATE SHIPPING ADDRESS

Confirmed by:
Dated:

DAMPER DETAILS



Page	38 of 39
Date	3/7/2005
Revision #	initial
Drawing By	SBP

N.O. = NORMALLY OPEN
N.C. = NORMALLY CLOSED
PAR. = PARALLEL BLADES
OPP. = OPPOSED BLADES

TORQUE (INCH POUNDS) REQUIRED PER SQUARE FOOT OF DAMPER:	7.0

AUTOMATIC TEMPERATURE CONTROL DAMPER SCHEDULE

ITEM	TAG ID	MECHANICAL DRAWING REFERENCE	DESCRIPTION	QTY	SUBMITTED SIZE WIDTH (inches)	SUBMITTED SIZE HEIGHT (inches)	APPROVED SIZE WIDTH (inches)	APPROVED SIZE HEIGHT (inches)	BLADE ACTION (CHECK PAR OR OPP) PARALLEL	BLADE ACTION (CHECK PAR OR OPP) OPPOSED	FAIL POSITION (N.O. - OPEN, N.C. CLOSED)	MANUFACTURER	MODEL NUMBER	SUBMITTED AIRFLOW (CFM)	SUBMITTED VELOCITY (FPM)	TORQUE REQ'D (IN.LB.)
1	D1	M3.2	AHU-5 Outdoor air damper	1	18	14			X		N.C.	Ruskin	CD46	430	246	12.3
2	D2	M3.2	AHU-5 Relief air damper	1	14	18			X		N.C.	Ruskin	CD46	430	246	12.3
3	D1	M3.1	SF-1 Intake damper	1	48	30			X		N.C.	Ruskin	CD46	2085	209	70.0
4	D1	M3.1	Exh. Fan EF-6 Damper	1	16	14			X		N.C.	Ruskin	CD46	1200	771	10.9
5	D1	M3.1	Exh. Fan EF-7 Damper	1	10	10			X		N.C.	Ruskin	CD51	360	518	4.9
6	D1	M3.3	Fan coil unit #1 Outdoor air	1	6	6			X		N.C.	Ruskin	CD46	60	240	1.8
7	D4	M3.1	Room 237 Remote Relief damper	1	64	44			X		N.C.	Ruskin	CD46	15770	806	136.9
8	D4	M3.2	Room 214 Remote Relief damper	1	102	60			X		N.C.	Ruskin	CD46	15770	371	297.5
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

COMMENTS:
** Item #7 to be made up of 2 sections 32"h X 44"w overall 64x44
** Item #8 to be made up of 4 sections 25.5"h X 60"w overall 102x60

rev: 11/06/2001
file: dmpschda.xls

A

Invensys Dominion Energy Management
11250 Hopson Road
Ashland, Virginia 2300
Phone: 804-798-3189
FAX: 804-798-3878

Project Name:	
Project Number:	
Owner:	
Engineer:	
Contractor:	

Page:	
Date:	
Revision #:	
Approved:	

Air Flow Station Shipping Information:	
Address:	
Mark Shipment:	

AIR FLOW MONITORING STATION SCHEDULE

ITEM	TAG ID	MECHANICAL DRAWING REFERENCE	DESCRIPTION	QTY	SUBMITTED SIZE		APPROVED SIZE		MANUFACTURER	MODEL NUMBER	SUBMITTED		REMARKS AND COMMENTS
					WIDTH (inches)	HEIGHT (inches)	WIDTH (inches)	HEIGHT (inches)			AIRFLOW (CFM)	VELOCITY (FPM)	
1	AFMS1	n/a	AHU-1 Exhaust Fan Inlet	1	*	*			Ultratech	FIAMP8	16090	TBD	Size will be determined by field measurement
2	AFMS1	n/a	AHU-2 Exhaust Fan Inlet	1	*	*			Ultratech	FIAMP8	18330	TBD	Size will be determined by field measurement
3	AFMS1	n/a	AHU-3 Exhaust Fan Inlet	1	*	*			Ultratech	FIAMP8	6000	TBD	Size will be determined by field measurement
4	AFMS1	n/a	AHU-6 Exhaust Fan Inlet	1	*	*			Ultratech	FIAMP8	3725	TBD	Size will be determined by field measurement
5	AFMS1	n/a	AHU-8 Exhaust Fan Inlet	1	*	*			Ultratech	FIAMP8	6900	TBD	Size will be determined by field measurement
6													
7													
8													
9													
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19													
20													

rev: 3/18/98

file: afmschda.xls

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 any and 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 architectural, structural, mechanical and plumbing drawings, 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 architectural, structural, mechanical, and plumbing 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 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
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
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 (disconnect switches 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:
Disconnect Switches	Product Data
General Electric / ABB Company	
Square D Company	
Eaton/Cutler-Hammer	
Siemens	
Wiring Devices and Cover Plates	Product Data
Hubbell	
Leviton	
Arrow-Hart	
Pass and Seymour	

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

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 RECORD DRAWINGS

A. Refer to Specification Section 017839 “Project Record Documents”.

3.5 OPERATION AND MAINTENANCE MANUALS

A. Refer to Specification Section 017823 “Operation and Maintenance Data”.

The following list states materials for which Operation and Maintenance Data submittals shall be made:

Fire Alarm System Components
Power Distribution Equipment (Disconnect Switches)
Short Circuit Coordination Study and Arc Flash Hazard Analysis

3.6 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:

Fire Alarm System Components
Power Distribution Equipment (Disconnect Switches)

APPENDIX A

New Equipment Inventory

Project Name: (Add Project Name)

Project Address: (Add Project Address)

Description of Item: _____
(ex. Switchboard, Panelboards, Generator, Lighting, etc.)

Classification:

- ☐ Lighting
- ☐ Power Distribution
- ☐ Auxiliary Systems

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 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 and 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.

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.

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.

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 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. 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 _____

2. Disconnect Switches: Disconnect switches shall be labeled in 1/4" high letters. First line shall state what the switch 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.

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.

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 DISCONNECTING MEANS

A. Provide a disconnecting means for each motor where indicated on the drawings. A circuit breaker in a panelboard or horsepower rated switch 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. Wiring sizes #12 and #10 AWG shall be solid. Larger sizes may be stranded.

J. Neutral conductors shall not be under sized.

K. 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 circuit, feeder, and control wiring shall be color coded. The color shall be integral with sheath 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

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; 1/2" 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.

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.

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.

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; to brick and concrete with expansion bolts; to metal surfaces with machine screws; and to wood with wood screws.

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.

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.

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.

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 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 HD 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 Owner/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 262726 - WIRING DEVICES AND DEVICE PLATES

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. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of the electrical distribution systems which are intended to carry but not utilize electric energy.

B. Types of electrical wiring devices in this Section include the following:

Receptacles
Ground-fault circuit interrupters
Cover plates
Plugs and Connectors

C. Comply with the requirements of the NEC, as applicable to installation and wiring of electrical wiring devices.

D. Comply with applicable requirements of UL 20, 486A, 498, 943, and 1472 pertaining to installation of wiring devices. Provide wiring devices which are UL-Listed and labeled.

E. Comply with applicable portions of NEMA WD1, "General-purpose Wiring Devices, and WD5, "Wiring Devices, Specific Purposes."

PART 2 - PRODUCTS

2.1 FABRICATED WIRING DEVICES

A. Provide factory-fabricated wiring devices in types and electrical ratings for applications indicated and which comply with NEMA WD1. Provide ivory colored-devices.

2.2 RECEPTACLES

A. Duplex: Provide Industrial/Institutional, Specification-Grade, Tamper Resistant TR duplex receptacles, 2-pole, 3-wire, grounding, with green hexagonal equipment ground screw, single-

piece brass mounting yoke with integral ground terminals, 20 amperes, 125 Volts, with metal plaster ears; designed for side and back wiring, with NEMA configuration 5-20R, unless otherwise indicated. LEVITON 5362, Tamper Resistant TR Series, or approved equal.

B. Ground-fault Circuit Interrupters: Provide Industrial/Institutional, Specification-Grade, Tamper Resistant TR, "feed-thru"-type ground-fault circuit interrupters, with heavy-duty duplex receptacles, capable of being installed in a 2-3/4" deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20 amperes, 120 Volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 mA ground-fault trip level; equipped with NEMA configuration 5-20R. LEVITON model 7899, Tamper Resistant TR Series, or approved equal.

C. Ground-fault Weather Resistant Circuit Interrupters; Provide Industrial/Institutional, Specification-Grade, Tamper Resistant TR, "feed-thru"-type ground-fault circuit interrupters, with heavy-duty duplex receptacles, capable of being installed in a 2-3/4" deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20 amperes, 125 Volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 mA ground-fault trip level; equipped with NEMA configuration 5-20R. LEVITON model WR899-W, Tamper Resistant TR or approved equal.

2.3 WIRING DEVICE ACCESSORIES

A. Cover plates: Provide mid-size (JR Jumbo) ivory colored cover plates for single and combination wiring devices of types and with ganging and cutouts as required. Provide metal screws for securing plates to devices; screw heads colored to match color of plates. Provide stainless-steel cover plates in mechanical and electrical equipment rooms.

B. Provide "metal extra duty weatherproof-while-in-use" rated cover plates for receptacles installed outdoors where exposed to weather.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

A. Install wiring devices where indicated in Contract Documents 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.

B. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

C. Install wiring devices only in electrical boxes which are clean, free from building materials, dirt, and debris.

D. Install wiring devices after wiring work is completed.

E. Install cover plates after painting work is completed. Label the inside face of each cover plate with indelible black marker indicating the number of each circuit contained in or running through the outlet box.

F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B. Use properly scaled torque indicating hand tool.

G. Terminate all switch and receptacle wiring on side screw terminals. Back terminations are not permitted.

H. Install all switches and receptacles with sufficient wiring length such that the device may be extracted from the outlet box a minimum of 6" while still connected.

3.2 PROTECTION OF COVER PLATES AND RECEPTACLES

A. Upon installation of cover plates and receptacles, take caution regarding use of convenience outlets. At time of Substantial Completion, replace all cover plates and receptacles which have been damaged; during the execution of this project; including those painted over, burned, or scored by faulty plugs.

3.3 GROUNDING

A. Provide equipment grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

3.4 TESTING

A. Prior to energizing circuitry, test wiring for electrical continuity and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

END OF SECTION 262726