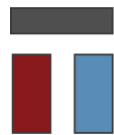


PROJECT MANUAL

HVAC System Replacement Menchville High School Newport News Public Schools Newport News, Virginia

IFB # 003-0-2026/SB

STATE PROJECT NO. 117-122-00-102



THOMPSON
CONSULTING ENGINEERS

*Mechanical and Electrical Engineering
22 Enterprise Parkway, Suite 120
Hampton, Virginia 23666*



TCE Project No. 23-065

September 8, 2025

Permit Set

HVAC REPLACEMENT
MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA

SECTION 000002 - PROJECT DIRECTORY

Owner: Newport News Public Schools
12580 Patrick Henry Drive
Newport News, Virginia 23602

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Structural
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McPherson Design Group
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END OF SECTION 000002

HVAC Replacement – Menchville High School
Newport News Public Schools
September 8, 2025

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SECTION 000820 - SPECIAL CONDITIONS

1. SAFETY:

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.

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.

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.

All poisonous or otherwise hazardous material will be kept in locked containers when not in use or left unattended.

Contractor's personnel will strictly adhere to all traffic regulations, traffic patterns, and speed limits.

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.

- f. Asbestos and all Materials Containing Asbestos: Asbestos containing materials (ACM) are present in the areas of work of this project. All known materials shall be identified to the Contractor by the Owner prior to starting any work. The Contractor is responsible for the removal of all ACM required by the work of this project. If the Contractor, during the course of Work, observes or suspects the existence of asbestos in an area of the Work, the Contractor shall promptly notify the Owner. The Owner will provide the Contractor with the instructions relative to the suspected asbestos material. The Contractor shall not perform any

work pertinent to the suspected asbestos material prior to receipt of special instruction from the Owner.

2. APPLICABLE STANDARDS AND CODES:

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)
VBPRR	Virginia Boiler and Pressure Vessel Rules and Regulations

3. FIRE PROTECTION:

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.

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.:

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. TEMPORARY FACILITIES:

The Contractor shall coordinate with Owner Representative for location of trailers, storage, and portable toilet at the pre-construction meeting.

The Contractor shall control workers at all times. Workers are not to use school lounges or telephones.

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.

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

6. UNDERGROUND SERVICES:

At all locations, all underground utilities or service lines uncovered or exposed by operations performed under the Contract shall be adequately protected by the Contractor. In the event of damage to underground utilities or service interruptions resulting from failure to follow all applicable procedures, the Contractor will be held responsible for resulting costs.

7. UTILITY OUTAGES:

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.

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.

If telephone, power, cable television, gas, or water lines are to be affected by proposed digging operations, the Contractor shall notify the applicable utility company(s) and request that they locate their utilities in the field.

8. ASBESTOS:

An asbestos inspection was performed, and asbestos-containing materials were found generally in the CMU block sealer. The asbestos report is included in Appendix A. NNPS shall handle all asbestos removal. Contractor shall coordinate schedule with owner to have access to areas of abatement.

END OF SECTION 000820

SECTION 000821 - OWNER'S SPECIAL RULES AND CONDITIONS

The following Rules and Conditions apply to this project. These Rules and Conditions take precedent if in conflict with other similar Rules and Conditions that appear elsewhere in this Specification.

- Contractor shall provide an on-site supervisor for the duration of the contract. Name and local telephone number will be provided to the Owner Representative.
- Contractor shall obtain and post all necessary permits. City Codes Compliance Department will inspect all aspects of the project for compliance with codes and regulations. Contractor's supervisor shall be present during all inspections.
- Contractor shall coordinate with Owner Representative for location of trailers, storage and portable toilet.
- 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 permission.
- Contractor will be responsible for removal and proper disposal of all debris and materials generated by the project.
- Contractor shall provide safety barriers or tape around project areas. Contractor shall secure equipment and materials at all times.
- Contractor shall control workers at all times. Workers are not to use school lounges or telephones.
- Smoking is not permitted.
- Any damages sustained through the fault of the contractor shall be repaired or repaid by the contractor.
- Warranty periods shall not begin until final completion for each phase of the project.

END OF SECTION 000821

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-I Specification Sections, apply to this Section.

1.2 PURPOSE

- A. The project schedule calls for the work to be done in order to minimize the disruption of students and staff in and around the building.
- B. 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 by August 2, 2026, for Phase I and August 8, 2027, for Phase II. The Contractor shall pay as liquidated damages the sum of \$2,500.00 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 October 2, 2026, for Phase I and October 8, 2027, for Phase II. The Contractor shall pay as liquidated damages the sum of \$2,500.00 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 2026 and summer of 2027. 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. Temporary cooling is required in all media centers throughout each Summer Phase.
- 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:

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1. Provide split systems as indicated on drawings.
2. Provide new rooftop units as indicated on drawings.
3. Remove existing hot water piping, hot water pumps and boilers as identified on drawings.
4. Provide new hot water piping, hot water pumps and condensing boilers.
5. Replace exhaust fans as identified on the drawings.
6. Provide Commissioning for all new mechanical units, boilers, pumps, and controls.
7. All required electrical work to support the mechanical scope.

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.

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-I 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 Owner guidelines.
 - 6. Fraternalization 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 not use the restrooms throughout the school facility.
 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. The additions can generally be constructed with minimal disturbance of the existing school operation. There will be the need to provide construction tunnels for Life Safety issues. See Plans.
- 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.
- G. The Contractor shall be advised of the schedule required for the installation of loose furniture, equipment, appliances, etc. as provided by the Owner under separate contract(s) in order to allow time for installation by the owner's forces.

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-I 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:
 - 1. Provide split systems as indicated on drawings.
 - 2. Provide new rooftop units as indicated on drawings.
 - 3. Remove existing hot water piping, hot water pumps and boilers as identified on drawings.
 - 4. Provide new hot water piping, hot water pumps and condensing boilers.
 - 5. Replace exhaust fans as identified on the drawings.
 - 6. Provide Commissioning for all new mechanical units, boilers, pumps, and controls.
 - 7. All required electrical work to support the mechanical scope.

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.

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-I 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 2026 and Summer 2027.
- 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.

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- C. Limit use of the premises to construction activities in areas indicated; allow for Owner occupancy and use by the public. Confine operations to areas within limits 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 trees indicated to remain shall have protection devices provided, and the Contractor shall instruct all employees to prevent damage to trees and root systems. 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 the site. Refer to drawing G-001 for areas indicated for parking and staging of equipment/materials. All materials stored onsite shall be secured in contractors locked construction trailer. All other parking areas shall not be used without owner's prior approval.
- 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. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.
- H. 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.
- I. 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 News Public School 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 shall take place over two Summers (in phases). Construction work may be done between the hours of 7:00 A.M. and 10:00 P.M., Monday through Thursday during that timeframe. With the Owner's prior approval, work may be done Friday through 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, and schedule such work so as not interrupt normal school operations. Coordinate with the LOCALITY to ensure that all underground utilities are marked prior to start of work by Dominion Virginia Power. Coordinate with the LOCALITY Fire Marshal all fire system work and adhere to all requirements of the Fire Marshal for protection of the building.

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- 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, Carpet, Desks, Chairs, and Cabinetry and Other Furnishings: Protect all existing desks, chairs, cabinetry, chalkboards, tackboards, and any other attached or unattached furnishings in the project areas with a minimum 6-mil polyethylene sheeting. 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.
 - 1. Contractor shall protect all existing flooring surfaces from damage during the entire construction period. The Contractor shall cover all existing floors with 45-mil thick heavy-duty rolled cardboard temporary floor protection, "Ram Board" or equal, with adjacent sections of cardboard taped to each other with painter's tape or non-residue tape. Floor protection shall be secured to baseboards in a similar fashion to protect floors.
- 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.

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 Notice of Award, 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.

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- 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.
 - 3. Email a digital "draft copy" with DRAFT watermark on each page to the Engineer for review and concurrence prior to sending the final digital copy.
- F. Transmittal: Submit **a final digital copy 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.
 - 1. Email digital copy to Construction Administration Department at: CA@tceva.com.
 - 2. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to the Engineer.
- G. 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.
- H. Waiver Forms: Submit waivers of lien on forms, and executed in a manner, acceptable to Owner.
- I. 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.
- J. 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 records.
 - 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.
- K. 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)

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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.

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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-I 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. Subcontractors list: Within 10 days after award, submit a list of all subcontractors; identify individuals, their duties and responsibilities; list their address and telephone numbers.
- C. 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.

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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 the 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 bi-weekly intervals or as required. Coordinate dates of alternate meetings with preparation of the payment request. The Engineer or the Owner's Construction Program 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: _____

Telephone: Office
 Field
 Cell

b. With Engineer:

Project Engineer will be: _____

Company: _____

Street: _____

P.O. Box: (if any) _____

City & Zip: _____

Attention: _____

Telephone: Office
 Field
 Cell

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- 1) For questions, information, etc., Attn:_____
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 Architect 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. List of specific work performed, and hours worked each day by each general contractor
 3. List of specific work performed, and hours worked each day by each subcontractor
 4. Approximate count of personnel at the site.
 5. High and low temperatures, general weather conditions.
 6. Accidents and unusual events.
 7. Include measured amount of precipitation at project site, occurring daily during period since previous report.
 8. Meetings and significant decisions.
 9. Stoppages, delays, shortages, losses.
 10. Meter readings and similar recordings.
 11. Emergency procedures.
 12. Orders and requests of governing authorities.
 13. Change Orders received, implemented.
 14. Services connected, disconnected.
 15. Equipment or system tests and start-ups.
 16. Partial Completions, occupancies.
 17. 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 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 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 if 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 “Building Construction and Demolition Operations”, ANSI-A10 Series standards for “Safety Requirements for Construction and Demolition”, 2021 International Fire Code (Chapter 33), NFPA 241-2019 for conditions not covered by the IFC (Chapter 33).

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.
- C. Contractor shall comply with all applicable requirements for fire prevention measures detailed within IFC 2018 (Chapter 33) and NFPA 241 (for conditions not covered by the IFC) during construction and demolition, in addition to the following instructions:
 - 1. Fire extinguishers shall be maintained throughout the building during construction. All work areas shall have at least one fire extinguisher sized for ordinary hazard. Travel distance to a fire extinguisher within a work area shall not exceed the maximum allowable distance specified in NFPA 10. Additional fire extinguishers shall be provided in every storage and construction shed on-site and where special hazards exist, including the storage and use of flammable and combustible liquids.
 - 2. Where a fire protection or fire alarm system is out of service, the fire department and the State Fire Marshal shall be notified immediately and, where required by the State Fire Marshal, the building shall either be evacuated, or approved fire watch shall be provided for all occupants left unprotected by the shut down until the fire protection/fire alarm system has been returned to service. The required fire watch shall be approved by the State Fire Marshal and shall comply with IFC Section 901.7.

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 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.

1.8 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.

1.9 SANITARY FACILITIES

- A. Provide and maintain temporary toilets as necessary for use of all construction personnel. Place toilets in convenient locations, and maintain in sanitary condition. Provide portable container or sanitary bubbler drinking fountains.
- B. Provide adequate washing facilities for all construction personnel. Place in convenient locations.
- C. Existing toilet facilities shall not be used by construction personnel.
- D. Sanitary facilities shall be located as directed by Owner. Provide sanitary facilities for the duration of the project including the punch list period.

1.10 SIGNS

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

1.11 FIRE PROTECTION

- A. Provide temporary fire protection as required by the State Fire Marshal 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. Where fire protection systems are out of service, the fire department, the State Fire Marshal, and any State Fire Marshal shall be notified immediately and, where required by the State Fire Marshal, the building shall either be evacuated, or an approved fire watch shall be approved by the State Fire Marshal that complies with IFC Section 901.7. The approved fire watch shall be provided for all occupants left unprotected by the shut down until the fire protection/fire alarm system has been returned to service.

1.12 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.

1.13 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.

1.14 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.

1.15 OSHA (Occupational Safety and Health Act)

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

1.16 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. Sanitary facilities include temporary toilets, wash facilities and drinking water fixtures. Comply with regulations and health codes for the type, number, location, operation and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.
- G. Provide toilet tissue, paper towels, paper cups and similar disposable materials for each facility. Provide covered waste containers for used material.
- H. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.
- I. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a healthy and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.
- J. Drinking Water Facilities: Provide containerized tap-dispenser bottled-water type drinking water units, including paper supply.
- K. Temporary cooling is required in all media centers throughout each Summer Phase.

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.

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- 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 26.

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.

<u>ITEM</u>	<u>STATUS</u>
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	Contractor will provide
Consent of the Surety Company to final payment General Release from Contractor	Contractor will provide
Release of Liens from Major Subcontractors	Contractor will provide
Affidavit of the Contractor that all Subcontractors and material men have been paid in full	Contractor will provide
Written certification from the Contractor to the Engineer and Owner that no asbestos containing materials or products were included in the Project	Contractor will provide
Record Drawings	Contractor will provide
Record Specifications	Contractor will provide
Operations and Maintenance Manuals	Contractor will provide
Standard Warranty from Contractor	Contractor will provide
Special Warranties from Materials & Equipment Suppliers	Contractor will provide
Cost proposals for all outstanding changes in the Contract.	Contractor will provide
Final Application and Certificate for Payment	Contractor will provide

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

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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-I 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

HVAC SYSTEM REPLACEMENT – MENCHVILLE HIGH SCHOOL
(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. Equipment inventory, refer to specification sections 230100 and 260100.
 8. 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.

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- 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 two bound copies of the manual and a two CD's containing an electronic version of the Manual in PDF format to the 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 26.
- 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

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- 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-I 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 024119 - SELECTIVE DEMOLITION

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. Demolition and removal of mechanical and electrical items as indicated.
 - 2. Patching and repairs.

1.3 DEFINITIONS

- A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.
- B. Remove and Salvage: Items indicated to be removed and salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.
- C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.
- D. Existing to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Engineer, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.

1.4 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections, for information only, unless otherwise indicated.

- B. Proposed dust-control measures.
- C. Proposed noise-control measures.
- D. Schedule of selective demolition activities indicating the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
 - 2. Detailed sequence of selective demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.
 - 3. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Inventory of items to be removed and salvaged.
- F. Inventory of items to be removed by Owner.
- G. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.
- H. Record drawings at Project closeout according to Division 1 Section "Contract Closeout."
- I. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.
- J. Landfill records indicating receipt and acceptance of hazardous wastes by landfill facility licensed to accept hazardous wastes.

1.6 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Engage an experienced firm that has successfully completed selective demolition Work similar to that indicated for this Project.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before starting selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.7 PROJECT CONDITIONS

- A. Owner will occupy portions of the building immediately adjacent to selective demolition area. Conduct selective demolition so that Owner's operations will not be disrupted. Provide not less than 48 hours' notice to Owner of activities that will affect Owner's operations.
- B. Owner assumes no responsibility for actual condition of buildings or equipment to be selectively demolished.

- C. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- D. Storage or sale of removed items or materials on-site will not be permitted.

1.8 SCHEDULING

- A. Arrange selective demolition schedule so as not to interfere with Owner's on-site operations.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
- B. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
- C. Use materials whose installed performance equals or surpasses that of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Engineer.
- E. Survey the condition of the building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition.
- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

- A. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.
- C. Provide not less than 48 hours' notice to Owner if shutdown of service is required during changeover.
- D. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services serving building to be selectively demolished.
 - 1. Arrange to shut off indicated utilities with utility companies.
 - 2. Where utility services are required to be removed, relocated, or abandoned, provide bypass connections to maintain continuity of service to other parts of the building before proceeding with selective demolition.
- E. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal the remaining portion of pipe or conduit after bypassing.

3.3 PREPARATION

- A. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
- B. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- C. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area.
- D. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
- E. Protect existing site improvements, appurtenances, and landscaping to remain.
- F. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
- G. Provide temporary weather protection, during interval between demolition and removal of existing construction, on exterior surfaces and new construction to ensure that no water leakage or damage occurs to structure or interior areas.
- H. Protect walls, ceilings, floors, and other existing finish work that are to remain and are exposed during selective demolition operations.

- I. Cover and protect furniture, furnishings, and equipment that have not been removed.
- J. Weatherstrip openings.
- K. Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of building to be selectively demolished.
- L. Strengthen or add new supports when required during progress of selective demolition.

3.4 POLLUTION CONTROLS

- A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.
- B. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- C. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- D. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level.
- E. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before start of selective demolition.

3.5 SELECTIVE DEMOLITION

- A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
- B. Proceed with selective demolition systematically, from higher to lower level.
- C. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
- D. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
- E. Do not use cutting torches without the express written consent of the Owner's Representative.
- F. Maintain adequate ventilation when using cutting torches.

- G. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
- H. Locate selective demolition equipment throughout the structure and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- I. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.
- J. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.
- K. Remove air-conditioning equipment without releasing refrigerants.

3.6 PATCHING AND REPAIRS

- A. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.
- B. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
- C. Completely fill holes and depressions in existing masonry walls to remain with an approved masonry patching material, applied according to manufacturer's printed recommendations.
- D. Restore exposed finishes of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.
- E. Patch, repair, or re-hang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.8 CLEANING

- A. Sweep the demolition area broom clean on completion of selective demolition operation.

END OF SECTION 024119

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including Special Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in-place concrete, including reinforcement, concrete materials, mix design, placement procedures, and finishes.

1.3 SUBMITTALS

- A. General: In addition to the following, comply with submittal requirements in ACI 301.
- B. Product Data: For each type of manufactured material and product indicated.
- C. Design Mixes: For each concrete mix.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualifications: A firm experience in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- C. Source Limitations: Obtain each type of cement of the same brand for the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- D. Comply with ACI 301, "Specification for Structural Concrete," including the following, unless modified by the requirements of the Contract Documents.
 - 1. General requirements, including submittals, quality assurance, acceptance of structure, and protection of in-place concrete.
 - 2. Steel reinforcement and supports.
 - 3. Concrete mixtures.
 - 4. Handling, placing, and constructing concrete.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Wire: ASTM A82, as drawn.

2.2 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150, Types I or II.
- B. Normal-Weight Aggregate: ASTM C33, uniformly graded, not exceeding 1-1/2" nominal size.
- C. Water: Potable and complying with ASTM C94.

2.3 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1% water-soluble chloride ions by mass of cement and to be compatible with other admixtures. Do not use admixtures containing calcium chloride.
- B. Water-reducing Admixture: ASTM C494, Type A.
- C. High-range, Water-reducing Admixture: ASTM C494, Type F.
- D. Water-reducing and Accelerating Admixture: ASTM C494, Type E.
- E. Water-reducing and Retarding Admixture: ASTM C494, Type D.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-retaining cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

2.5 CONCRETE MIXES

- A. Comply with ACI 301 requirements for concrete mixtures.
- B. Prepare design mixes, proportioned according to ACI 301, for normal-weight concrete determined by either laboratory trial mix or field test databases, as follows:
 - 1. Compressive Strength (28 Days): 3,000 psi.

2. Slump: 4".

2.6 CONCRETE MIXING

- A. Ready-mixed Concrete: Comply with ASTM C94 and ASTM C1116.

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

PART 3 - EXECUTION

3.1 STEEL REINFORCEMENT

- A. Comply with CRSI "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.2 CONCRETE PLACEMENT

- A. Comply with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.
- B. Do not add water to concrete during delivery, at Project site, or during placement.

3.3 FINISHING UNFORMED SURFACES

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

3.4 TOLERANCES

- A. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3.5 CONCRETE PROTECTION 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 follow recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb./sq. ft. 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. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure formed and unformed concrete for at least 7 days by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12" lap over adjacent absorptive covers.
 - 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", and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage in qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Tests will be performed according to ACI 301.
 - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

3.7 REPAIRS

- A. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION 033000

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.

1.2 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shop primer.
4. Galvanized-steel primer.
5. Galvanized repair paint.

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

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Mill test reports for structural-steel materials, including chemical and physical properties.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
1. ANSI/AISC 303.
 2. ANSI/AISC 360.
 3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
1. Option 1: Connection designs have been completed and connections indicated on the Drawings.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M.
- B. Channels, Angles: ASTM A36/A36M.
- C. Plate and Bar: ASTM A36/A36M.
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B structural tubing.
- E. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
- F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
1. Finish: Hot-dip zinc coating.

2.4 PRIMER

A. Steel Primer:

1. Fabricator's standard lead- and chromate-free, non-asphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer: MPI#26, MPI#80, MPI#134.

1. Etching Cleaner: MPI#25, for galvanized steel.
2. Galvanizing Repair Paint: ASTM A780/A780M.

2.5 FABRICATION

- ### A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

2.6 SHOP CONNECTIONS

- ### A. 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 GALVANIZING

- ### A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.8 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 of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
 2. SSPC-SP 3.
- C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.
- D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. 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 in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Maintain erection tolerances of structural steel within ANSI/AISC 303.

3.3 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type 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.
1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a 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.
 - 1. Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 - 2. Welded Connections: Visually inspect field welds in accordance with 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 bearing and leveling plates.
 - 2. Steel framing and support for applications where framing and supports are not specified in other Sections.
- B. Related Sections include the following:
 - 1. Division 5 Section "Structural Steel" for structural-steel framing system components.

1.3 SUBMITTALS

- A. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 1. Provide templates for anchors and bolts specified for installation under other Sections.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing metal fabrications like those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 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 construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

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, which 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: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500.
- C. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
- D. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

- E. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welding.

2.3 PAINT

- A. Shop Primer for Ferrous Metal: Organic zinc-rich primer, complying with SSPC-Paint 20 and compatible with topcoat.

2.4 FASTENERS

- A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36.
- D. Machine Screws: ASME B18.6.3.
- E. Plain Washers: Round, carbon steel, ASME B18.22.1.
- F. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
- H. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as needed.

2.5 GROUT

- A. Non-shrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
- B. Non-shrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. 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. Shear and punch metals cleanly and accurately. Remove burrs.
- C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. 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 undercutting or overlapping.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smoothly and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- E. Provide for anchorage of type indicated, coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- H. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- I. Remove sharp or rough areas on exposed traffic surfaces.
- J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.7 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.8 LOOSE STEEL LINTELS

- A. Fabricate loose structural-steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Weld adjoining members together to form a single unit where indicated.
- C. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 8 inches, unless otherwise indicated.
- D. Hot-dip galvanize loose steel lintels located in exterior walls.

2.9 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports indicated and as necessary to complete the Work.
- B. Fabricate units from structural-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. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors 1-1/4 inches wide by 1/4 inch thick by 8 inches long at 24 inches o.c., unless otherwise indicated.
 - 2. Furnish inserts if units must be installed after concrete is placed.

2.10 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.

2.11 STEEL AND IRON FINISHES

- A. 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): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- B. 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," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- B. 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.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. 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.
- E. 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 undercutting or overlapping.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smoothly and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.2 SETTING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use non-shrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use non-shrink, nonmetallic grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings, if any.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

END OF SECTION 055000

SECTION 075113 - BUILT-UP ASPHALT ROOFING

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. Built-up asphalt roof membrane repair.
- B. Related Sections include the following:
 - 1. Division 6 Section "Rough Carpentry" for wood blocking, curbs, cants, and nailers; and wood-based, structural-use roof deck panels.
 - 2. Division 7 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
 - 3. Division 7 Section "Joint Sealants"

1.3 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D 1079 for definitions of terms related to roofing work not otherwise defined in this Section.
- B. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoises for mop-applied roofing asphalt and 75 centipoises for mechanical spreader-applied roofing asphalt within a range of plus or minus 25 deg F measured at the mop cart or mechanical spreader immediately before application.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Install a watertight, built-up roofing and base flashing roofing system with compatible components that will not permit the passage of liquid water and will withstand wind loads, thermally induced movement, and exposure to weather without failure.

1.5 SUBMITTALS

- A. Product Data: For each type of roofing product specified. Include data substantiating that materials comply with requirements.

- B. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install specified roofing system and is eligible to receive the roofing manufacturer's warranty.
- C. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names, and addresses of architects and owners, and other information specified.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an installer to perform Work of this Section who has at least five years' experience in installing roofing similar to that required for this Project; who is approved, authorized, or licensed by the roofing system manufacturer to install manufacturer's product; and who is eligible to receive the no-dollar-limit roofing manufacturer's warranty.
- B. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method indicated below by UL, FM, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Exterior Fire-Test Exposure: Class A; complying with ASTM E 108, for application and slopes indicated.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store roofing materials in a dry, warm, well-ventilated, weathertight location according to roofing system manufacturer's written instructions. Store rolls of felt and other sheet materials on end on pallets or other raised surfaces. Do not double-stack rolls.
 - 1. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.
- B. Do not leave unused felt and other sheet materials on the roof overnight or when roofing work is not in progress unless protected from weather and moisture and unless maintained at a temperature exceeding 50 deg F.
- C. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
- D. Protect roofing insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to manufacturers' written instructions and warranty requirements.

PART 3 - PRODUCTS

3.1 ROOF MEMBRANE PLIES

- A. Ply Felt: Asphalt-impregnated, glass-fiber felt, complying with ASTM D 2178, Type VI (6).

3.2 FLASHING MATERIALS

- A. Flashing Backer SBS Sheet: ASTM D 6163, Type 1 Grade S glass fiber reinforced. Minimum thickness 120 mils Tensile Strength 95 lbs. force/in. machine direction and Minimum Tensile Tear 105 lbs./in machine direction. Torch-applied.
- B. Flashing SBS Cap Sheet: ASTM D 6163, Type 1 Grade G glass fiber reinforced. Minimum thickness 160 mils. Tensile Strength 135 lbs. force/in. machine direction and Minimum Tensile Tear 125 lbs./in machine direction. Torch-applied.
 - 1. Granule Color: White.

3.3 ASPHALT MATERIALS

- A. Roofing Asphalt: ASTM D 312, Type III.
 - 1. Label each container or provide certification with each load of bulk asphalt identifying type of roofing asphalt and indicating softening point, minimum flash point, equiviscous temperature, and finished blowing temperature.

3.4 AUXILIARY MEMBRANE MATERIALS

- A. General: Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with built-up roofing.
 - 1. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdiction.
- B. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application.

- C. Mastick Sealant: Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.
- D. Sealer for Roof Penetrations: Two-component elastomeric product. Use one of the following:
 - 1. Two-component flashing cement.
 - a. MBR Flashing Cement by Johns Manville.
 - 2. Two-component, solvent-free, polyurethane-based pourable sealer with the following characteristics:
 - a. Tensile strength: 200 PSI.
 - b. Hardness (Shore A): 30
 - c. Elongation: 200 percent.
 - d. Low temperature brittleness: -50 degrees F.
 - e. Solids: 100 percent.
- E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions of FM 4470; tested by manufacturer for required pullout strength; and acceptable to roofing system manufacturer.
- F. Lead Flashing for Plumbing Vent Stacks: 2-1/2-pound common desilverized pig lead.
- G. Lead Flashing for Roof Drains: 4-pound common desilverized pig lead.
- H. Other Metal Flashing Sheet: Metal flashing sheet is specified in Division 7 Section "Sheet Metal Flashing and Trim."
- I. Wood Cants: Wood cants are specified in Division 6 Section "Rough Carpentry."
 - 1. Instead of perlite or fiber cants, use wood cants where indicated or where required for support of a curb or other attached construction.
- J. Perlite Cants: High-density perlite board, complying with ASTM C 209 and ASTM C 165.
- K. Walkway Pads: Mineral-surfaced asphaltic composition panels, factory formed, nonporous, with a slip-resisting surface texture, manufactured specifically for adhering to built-up roofing as a protection course for foot traffic, of the following thickness:
 - 1. Thickness: 3/8 inch.
 - 2. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dyna-Tred; Johns Manville.
 - b. Whitewalk Roof Pads; W.R. Meadows.

- L. Aggregate Surfacing: Clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges, complying with ASTM D 1863.
- M. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer for intended use.

3.5 INSULATION MATERIALS

- A. General: Provide preformed, roofing insulation boards that comply with requirements, selected from manufacturer's standard sizes and of thicknesses indicated.
 - 1. Provide preformed, tapered insulation boards where indicated for sloping to drain. Fabricate with the following taper:
 - a. 1/4 inch per 12 inches, unless otherwise indicated.
 - 2. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
- B. Perlite Board Insulation: Rigid, mineral-aggregate thermal insulation board consisting of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal-coated, complying with ASTM C 728.
 - 1. Minimum thickness 3/4 inch. 1/2-inch board will not be accepted.

3.6 INSULATION ACCESSORIES

- A. General: Furnish roofing insulation accessories recommended by insulation manufacturer for intended use and compatible with sheet roofing material.
- B. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions of FM 4470, designed for fastening roofing insulation to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.
- C. Tapered Edge Strips: Rigid, perlite insulation board, complying with ASTM C 728.

PART 4 - EXECUTION

4.1 EXAMINATION

- A. Examine substrates, areas, and conditions under which roofing will be applied, with Installer present, for compliance with requirements.
- B. Verify that roof openings and penetrations are in place and set and braced and that roof drains are properly clamped into position.

- C. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at roof penetrations and terminations and match the thicknesses of insulation required.
 - 1. Verify that wood nailer strips are located perpendicular to roof slope and spaced according to requirements of roofing system manufacturer.
- D. Verify that flatness and fastening of metal roof decks comply with installation tolerances specified in Division 5 Section "Steel Deck."
- E. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units more than 1/16 inch out of plane.
- F. Do not proceed with installation until unsatisfactory conditions have been corrected.

4.2 PREPARATION

- A. Clean substrate of dust, debris, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

4.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install built-up roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-Up Roofing."
 - 1. Install roofing system according to applicable specification plates of NRCA's "The NRCA Roofing and Waterproofing Manual."
- B. Cant Strips: Install and secure preformed 45-degree cant strips at junctures of built-up roofing membrane system with vertical surfaces or angle changes greater than 45 degrees.
 - 1. Where wood cants are indicated in the Drawings, securely fasten to both horizontal and vertical surfaces.
 - 2. Where type of cant is not indicated, use perlite cant.
- C. Coordinate installing roofing system components so insulation and roofing plies are not exposed to precipitation or left exposed at the end of the workday or when rain is forecast.
 - 1. Provide cutoffs at end of each day's work to cover exposed ply sheets and insulation with a course of coated felt 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. Asphalt Heating: Heat roofing asphalt and apply within plus or minus 25 deg F of equiviscous temperature, unless otherwise required by roofing system manufacturer. Do not raise roofing asphalt temperature above the equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F of flash point. Discard roofing asphalt maintained at a temperature exceeding 500 deg F for more than 4 hours. Keep kettle lid closed, unless adding roofing asphalt.

1. Aggregate Surfacing: Limit temperature of asphalt flood coat to the minimum required for proper embedment of aggregate and the maximum that will permit retention of required coating weight based on slope of surface.
2. Substrate-Joint Penetrations: Prevent roofing asphalt from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction. If mopping is applied directly to substrate, tape substrate joints.

4.4 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system manufacturer's written instructions for installing roofing insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated and to Shop Drawings.
 1. Where tapered insulation is indicated, use untapered polyisocyanurate board insulation to obtain the required insulation value and apply tapered perlite boards to obtain the required taper.
- D. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush with ring of drain.
- F. Install insulation with long joints of insulation in continuous straight lines 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.

4.5 ROOF MEMBRANE INSTALLATION

- A. Install ply felts according to roofing system manufacturer's written instructions, starting at low point of roofing system. Align ply felts without stretching. Shingle side laps of ply felts uniformly

to achieve required number of membrane plies throughout. Shingle in direction to shed water. Extend ply felts over and terminate beyond cants.

1. Application: Embed each ply felt in a solid mopping of hot roofing asphalt applied at rate required by roofing system manufacturer, to form a uniform membrane without ply felts touching each other.
- B. Aggregate Surfacing: Promptly after installing and testing roof membrane, flashing, and stripping, flood-coat roof surface with 60 lb/100 sq. ft. of hot roofing asphalt. While flood coat is hot and fluid, cast the following average weight of aggregate in a uniform course:
 1. Aggregate Weight: 400 lb./100 sq. ft., average.
 2. If aggregate surfacing is delayed, promptly apply glaze coat of hot roofing asphalt at the rate of 10 lb/100 sq. ft.
- C. Walkway Pads: Install walkway pads at locations shown, using units of size indicated or, if not indicated, of manufacturer's standard size.
 1. Install walkway pads according to the recommendations and instructions of the roofing manufacturer.

4.6 FLASHING AND STRIPPING INSTALLATION

- A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing system manufacturer's written instructions and as follows:
 1. Flashing Sheet Application: Torch apply flashing sheet to concrete, block, or brick substrate. Nail base sheet to wood substrate. Use a smooth-surfaced base ply and a granular-surface top ply.
- B. Where height of base flashing is not indicated in the Drawings and there is no parapet above the base flashing, extend base flashing up walls or parapets a minimum of 12 inches above roof membrane and 4 inches onto field of roof membrane.
- C. Unless otherwise indicated, where roofs terminate at a parapet condition, extend base flashings continuously up the parapet wall and across the top blocking of the parapet to the outside edge.
- D. Mechanically fasten top of base flashing at 6-inch intervals at terminations and perimeter of roofing.
 1. Seal top termination of base flashing.
- E. Install stripping where metal flanges and edgings are set on built-up roofing according to roofing system manufacturer's written instructions.

1. Built-up Stripping: Install stripping of not less than 2 plies of roof membrane felt, setting each ply in a continuous coating of asphalt roofing cement, extended onto roof membrane 4 inches.

PART 5 - FIELD QUALITY CONTROL

5.1 PROTECTING AND CLEANING

- A. Protect built-up roofing membrane from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove built-up roofing that does not comply with requirements, repair substrates, reinstall roofing, and repair base flashings to a condition free of damage and deterioration at the time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075113

SECTION 076200 - SHEET METAL FLASHING AND TRIM

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 sheet metal flashing and trim:
 - 1. Formed low-slope roof flashing and trim.
 - 2. Formed equipment support flashing.
- B. Related Sections include the following:
 - 1. Division 7 Sections for installing sheet metal flashing and trim integral with roofing membrane.
 - 2. Division 7 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress because of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
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. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1.5 QUALITY ASSURANCE

- A. 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.

PART 2 - PRODUCTS

2.1 SHEET METALS

- A. Copper Sheet: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet.
- B. Lead Sheet: ASTM B 749, Type L51121, copper-bearing lead sheet.

2.2 UNDERLAYMENT MATERIALS

- A. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.
- B. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
- C. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft.

2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
 - 1. Nails for Copper Sheet: Copper, hardware bronze, or Series 300 stainless steel, 0.109 inch minimum and not less than 7/8 inch long, barbed with large head.
 - 2. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory-applied coating.
 - 3. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
 - 4. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
 - 5. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
- C. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
- D. Solder for Lead: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
- E. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanent elastic, non-sag, nontoxic, non-staining tape.
- F. Elastomeric Sealant: As specified in Division 7 Section "Joint Sealants."
- G. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.
- H. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.4 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
- B. 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.

- C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
- D. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
- E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
- G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
 - 1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" and FMG Loss Prevention Data Sheet 1-49 for application but not less than thickness of metal being secured.

2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Counterflashing: Fabricate from the following material:
 - 1. Copper: 16 oz./sq. ft.
- B. Flashing Receivers: Fabricate from the following material:
 - 1. Copper: 16 oz./sq. ft.
- C. Roof-Penetration Flashing: Fabricate from the following material:
 - 1. Lead: 4.0 lb./sq. ft., hard tempered.

2.6 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following material:
 - 1. Copper: 16 oz./sq. ft.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
 - 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Torch cutting of sheet metal flashing and trim is not permitted.
- B. 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 fabricator or manufacturers of dissimilar metals.
 - 1. Coat side of lead sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
 - 3. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.
- C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.
- E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
 - 1. Galvanized or Pre-painted, Metallic-Coated Steel: Use stainless-steel fasteners.
 - 2. Copper: Use copper, hardware bronze, or stainless-steel fasteners.

- H. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches except where pre-tinned surface would show in finished Work.
1. Do not solder pre-painted, metallic-coated steel sheet.
 2. Pre-tinning is not required for lead.
 3. Copper Soldering: Tin uncoated copper surfaces at edges of sheets using solder recommended for copper work.
 4. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

3.3 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal roof flashing and trim to comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.
- B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant.
1. Secure in a waterproof manner by means of anchor and washer at 36-inch centers.
- D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:
1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
 2. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.4 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.5 CLEANING AND PROTECTION

- A. Clean and neutralize flux materials. Clean off excess solder and sealants.
- B. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain a clean condition during construction.
- C. 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.

END OF SECTION 076200

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 1 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 9 Section "Non-Load-Bearing Steel Framing" for non-structural framing and suspension systems that support gypsum board.
 - 2. Division 9 painting Sections for primers and finish painting applied to gypsum board surfaces.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.4 QUALITY ASSURANCE

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

1.5 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.

1.6 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 panels that are wet, those that are moisture damaged, and those that are 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.

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 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum Co.
 - b. G-P Gypsum.
 - c. National Gypsum Company.
 - d. USG Corporation.
- B. Abuse-Resistant Type: Manufactured to produce greater resistance to surface indentation, through-penetration (impact resistance), and abrasion than standard, regular-type and Type X gypsum board.
 - 1. Core: 5/8 inch, Type X.
 - 2. Long Edges: Tapered.

2.3 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
 - a. Cornerbead.
 - b. Bullnose Bead: Provide only at locations indicated.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound. Use at underside of low partition cap terminations.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. Expansion (control) joint.
 - f. Curved-Edge Cornerbead: With notched or flexible flanges.

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 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 setting-type taping compound.
 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose 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. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

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. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:

1. Regular Type: As indicated on Drawings.
2. Abuse-Resistant Type: Generally, all walls exposed to view below 9'-0" above finished floor. Refer to partition types in Drawings for additional information.

B. Single-Layer Application:

1. On partitions/walls, apply gypsum panels, 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.
2. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
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 at locations indicated on Drawings and 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. LC-Bead: Use at exposed panel edges.
 3. L-Bead: Use where indicated.
 4. Curved-Edge Cornerbead: Use at curved openings.

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 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 4: At all exposed ceiling locations or exposed areas where abuse resistant gypsum board is not used.
4. Level 5: At all locations where abuse resistant gypsum board is used and exposed to view.
 - a. Primer and its application to surfaces are specified in other Division 9 Sections.

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 the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes ceilings consisting of acoustical panels and exposed suspension systems.

1.3 SUBMITTALS

- A. Product Data: For each type of product specified.
- B. Samples for Verification: Full-size units of each type of ceiling assembly indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
 - 1. 6" square samples of each acoustical panel type, pattern, and color.
 - 2. Set of 12" long samples of exposed suspension system members, including moldings, for each color and system type required.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- D. Product Test Reports: Indicate compliance of acoustical panel ceilings and components with requirements based on comprehensive testing of current products.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed acoustical panel ceilings similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Source Limitations for Ceiling Units: Obtain each acoustical ceiling panel from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
- C. Source Limitations for Suspension System: Obtain each suspension system from one source with resources to provide products of consistent quality in appearance and physical properties

without delaying the Work. Generally, delete subparagraph below unless ceiling units will fit only the same manufacturer's suspension system. Armstrong and USG Interiors offer both suspension systems and ceiling units.

- D. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
1. Fire-response tests were performed by UL, ITS/Warnock Hersey, or another independent testing and inspecting agency that is acceptable to authorities having jurisdiction and that performs testing and follow-up services.
 2. Surface-burning characteristics of acoustical panels comply with ASTM E1264 for Class A materials as determined by testing identical products per ASTM E84.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver acoustical panels and suspension system components 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 panels, permit them to reach room temperature and stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way and wearing clean latex gloves to avoid soiling panels or grid.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.7 COORDINATION

- A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
1. Acoustical Ceiling Units: Full-size units equal to two percent of amount of each type/pattern of acoustical panels installed.
 2. Suspension System Components: None required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Acoustical Panel Ceiling Schedule at the end of Part 3.

2.2 ACOUSTICAL CEILING PANELS

A. General:

1. All ceiling panel units herein specified are manufactured by ARMSTRONG WORLD INDUSTRIES, INC. Subject to compliance with performance and visual requirements, products by the following manufacturers may be provided
 - a. ARMSTRONG WORLD INDUSTRIES, INC.
 - b. THE CELOTEX CORPORATION
 - c. U. S. GYPSUM CO.
2. Provide noncombustible mineral fiber acoustical tile units, NRC 0.50 to 0.60, STC 35 to 39.
3. Unless otherwise noted on the drawings, all ceiling tiles shall be ACT Type 1.

- B. Acoustical Ceiling Tile Type: "Armstrong" Fine Fissured #1729, 24" x 24" x 5/8" thick, square edge, white.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C635 requirements.
- B. Metal Suspension System Characteristics: Comply with requirements indicated in the Acoustical Panel Ceiling Schedule at the end of Part 3.
- C. Finishes and Colors, General: Comply with NAAMM "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-coated Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, Direct Hung) will be less than yield stress of wire, but provide minimum 0.106" diameter wire.

- E. Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material and finish as that used for exposed flanges of suspension system runners.
 - 1. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 - 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- F. Hold-Down Clips for Non-Fire-Resistance-Rated Ceilings: For interior ceilings panels occurring within 20 feet of exterior doors, provide hold-down clips spaced 24" o.c. on all cross tees.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage, and other conditions affecting performance of acoustical panel ceilings.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with publications referenced below per manufacturer's written instructions and Cisca "Ceiling Systems Handbook."
 - 1. Standard for Ceiling Suspension System Installations: Comply with ASTM C636.
 - 2. Cisca Recommendations for Acoustical Ceilings: Comply with Cisca "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
- B. Suspend ceiling hangers from building's structural members and as follows:

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1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure; that are appropriate for substrate; and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, powder-actuated fasteners, or drilled-in anchors that extend through forms into concrete.
 6. Do not attach hangers to steel deck tabs.
 7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 8. Space hangers not more than 48" o.c. along each member supported directly from hangers, unless otherwise indicated; and provide hangers not more than 8" from ends of each member. Provide wire hangers within 6" of all four corners of recessed, lay-in fluorescent light fixtures to support the ceiling grid.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Screw attach moldings to substrate at intervals not more than 16" o.c. and not more than 3" from ends, leveling with ceiling suspension system to a tolerance of 1/8" in 12". Square cut corners (at rectangular corners, miter at angled corners) accurately and connect securely. Do not over-drive fasteners, deforming molding.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit. Wear clean latex gloves when handling acoustic panels; change gloves frequently to avoid soiling panels.
1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
 2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges and perimeter trim. Carefully cut

edges of panels that occur at perimeter trim to provide a clean, crisp reveal edge to match factory-cut reveal edges.

3. Paint cut panel edges remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
4. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated or required.
5. Protect light fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

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

3.5 ACOUSTICAL PANEL CEILING SCHEDULE

- A. Acoustical Panel Ceiling: Water-Felted, Mineral-Base, Lay-in Acoustical Panels -- where this designation is indicated, provide acoustical panels complying with the following:
 1. Products:
 - a. Acoustical Ceiling Tile Type: ACP 1, "Armstrong" Fine Fissured #1728, 24" x 24" x 5/8" thick, square edge, white.
 2. Panel Classification: ASTM E1264, Type III, mineral base with painted finish; Form 2, water felted.
 3. Panel Pattern: ASTM E1264 pattern designation (description) as specified by product designation.
 4. Color: White.
 5. Light Reflectance Coefficient: Not less than LR 0.85.
 6. Noise Reduction Coefficient: NRC 0.50.
 7. Ceiling Attenuation Class: Not less than CAC 35.
 8. Edge Detail: Beveled tegular edge.
 9. Thickness: 5/8" (minimum).
 10. Size: 24" by 24".

END OF SECTION 095113

SECTION 099100 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including Special Conditions and Division-1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation, painting, and finishing of exposed interior and exterior items and surfaces.
 - 1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop-priming and surface treatment specified under other Sections.
- B. Paint exposed surfaces whether or not colors are designated in schedules, except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Owner will select from standard colors or finishes available.
 - 1. Painting includes field-painting exposed bare and covered pipes (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment, existing floors, walls, and ceilings.
- C. Painting is not required on pre-finished items, finished metal surfaces, concealed surfaces, operating parts, and labels.
 - 1. Pre-finished items not to be painted include the following factory-finished components:
 - a. Finished mechanical and electrical equipment.
 - b. Light fixtures.
 - c. Switchgear.
 - d. Distribution cabinets.
 - 2. Operating parts not to be painted include moving parts of operating equipment, such as the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.

3. Labels: Do not paint over Underwriters Laboratories, Factory Mutual, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

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

1. Divisions 15 and 16: A detailed description of painting mechanical and electrical work is specified in Divisions 15 and 16, respectively. All painting is part of this Section.

1.3 SUBMITTALS

A. Product data for each paint system specified, including block fillers and primers.

1. Provide the manufacturer's technical information, including label analysis and instructions for handling, storage, and application of each material proposed for use.
2. List each material and cross-reference the specific coating, finish system, and application. Identify each material by the manufacturer's catalog number and general classification.
3. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

B. Samples for initial color selection in the form of manufacturer's color charts.

C. Samples for Verification Purposes: Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

1. Provide stepped samples, defining each separate coat, including primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture are achieved.
2. Provide a list of material and application for each coat of each sample. Label each sample as to location and application.
3. Submit samples on the following substrates for the Owner's review of color and texture only:
 - a. Ferrous Metal: Provide two 4" square samples of flat metal and two 8" long samples of solid metal for each color and finish.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to those indicated for the Project that have resulted in a construction record of successful in-service performance.

B. Single-source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

- C. Field Samples: On exterior and interior components, duplicate finishes of prepared samples.
1. Final acceptance of colors will be from job-applied samples.
 2. The Owner will select one surface to represent surfaces and conditions for each type of coating and substrate to be painted. Apply coatings on surface according to the schedule or as specified.
 - a. After finishes are accepted, this surface will be used to evaluate coating systems of a similar nature.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
1. Product name or title of material.
 2. Product description (generic classification or binder type).
 3. Manufacturer's stock number and date of manufacture.
 4. Contents by volume, for pigment and vehicle constituents.
 5. Thinning instructions.
 6. Application instructions.
 7. Color name and number.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45°F (7°C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.6 JOB CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50°F (10°C) and 90°F (32°C).
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45°F (7°C) and 95°F (35°C).
- C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85%; or at temperatures less than 5°F (3°C) above the dew point; or to damp or wet surfaces.
1. Painting may continue during inclement weather if surfaces and areas to be painted are

enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

Devoe and Raynolds Co. (Devoe).
Benjamin Moore and Co. (Moore).
PPG Industries, Pittsburgh Paints (PPG).
The Sherwin-Williams Company (S-W).

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide primers, finish coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.

- B. Material Quality: Provide the manufacturer's best-quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish the manufacturer's material data and certificates of performance for proposed substitutions.

- C. Colors: Provide color selections made by the Owner from the manufacturer's full range of standard colors.

2.3 PRIMERS

- A. Primers: Provide the manufacturer's recommended factory-formulated primers that are compatible with the substrate and finish coats indicated.

- B. Available Products: Subject to compliance with requirements, prime coat materials that may be incorporated in the Work include, but are not limited to, the following:

1. Ferrous Metal Primers: Alkyd-type primers.

Devoe: 41820 Bar-Ox Alkyd Shop/Field Primer Grey.
Moore: IronClad Retardo Rust-Inhibitive Paint #163.
PPG: 6-612 Speedhide Inhibitive White Primer.
P & L: Effecto Primer Red or White.
S-W: Kem Kromik Metal Primer B50N2/B50W1.

2. Galvanized Metal Primers:

Devoe: 13201 Mirrolac Galvanized Metal Primer.
Moore: IronClad Galvanized Metal Latex Primer #155.
PPG: 6-215/216 Speedhide Galvanized Steel Primer.
S-W: Galvite B50W3.

2.4 UNDERCOAT MATERIALS

- A. Undercoat Materials: Provide the manufacturer's recommended factory-formulated undercoat materials that are compatible with the substrate and finish coats indicated.
- B. Available Products: Subject to compliance with requirements, undercoat materials that may be incorporated in the Work include, but are not limited to, the following:

1. Interior Enamel Undercoat: Ready-mixed enamel.

Devoe: 51701 Wonder-Prime Interior All Purpose Latex Primer Sealer & Vapor Barrier.
Moore: Moore's Alkyd Enamel Underbody #217.
PPG: 6-6 Speedhide Quick-Dry Enamel Undercoater.
S-W: ProMar 200 Latex Wall Primer B28W200.

2.5 INTERIOR FINISH PAINT MATERIAL

- A. Finish Paint: Provide the manufacturer's recommended factory-formulated finish-coat materials that are compatible with the substrate and undercoats indicated.
- B. Available Products: Subject to compliance with requirements, finish coat materials that may be incorporated in the Work include, but are not limited to, the following:

1. Interior, Semi-gloss, Odorless Alkyd Enamel: Semi-gloss, low-odor, alkyd enamel.

Devoe: 26XX Velour Alkyd Semi-gloss Enamel.
Moore: Moore's Satin Impervo Enamel #235.
PPG: 27 Line Wallhide Semi-gloss Enamel.
S-W: Classic 99 Semi-gloss Enamel A40 Series.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions under which painting will be performed for compliance with paint application requirements. Surfaces receiving paint must be thoroughly dry before paint is applied.
 - 1. Do not begin to apply paint until unsatisfactory conditions have been corrected.
 - 2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 - 1. Notify the Owner about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items, if necessary, to completely paint the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease prior to cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to the manufacturer's instructions for each particular substrate condition and as specified.
 - 1. Provide barrier coats over incompatible primers or remove and re-prime. Notify Engineer in writing about anticipated problems using the specified finish-coat material with substrates primed by others.
 - 2. Cementitious Materials: Prepare surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen, as required, to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

- a. Use abrasive blast-cleaning methods if recommended by the paint manufacturer.
 - b. Previously Painted Surfaces: Prepare previously painted surfaces for new coatings in accordance with paint manufacturer's recommendations. Generally, remove loose material and attain uncontaminated surfaces. Clean nonporous surfaces with brush or steel wool and appropriate cleaner or solvent as recommended.
 - c. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
 3. Ferrous Metals: Clean ungalvanized ferrous metal surfaces that have not been shop-coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council (SSPC).
 - a. Blast steel surfaces clean as recommended by the paint system manufacturer and according to requirements of SSPC specification SSPC-SP 10.
 - b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.
 4. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- D. Materials Preparation: Carefully mix and prepare paint materials according to manufacturer's directions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
 3. Use only thinners approved by the paint manufacturer and only within recommended limits.
- E. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

- B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
1. Paint colors, surface treatments, and finishes are indicated in the schedules.
 2. Provide finish coats that are compatible with primers used.
 3. The number of coats and the film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth even surface according to the manufacturer's directions.
 4. Apply additional coats if undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
 5. The term exposed surfaces include areas visible when permanent or built-in items are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
 6. Sand lightly between each succeeding enamel or varnish coat.
 7. Omit primer on metal surfaces that have been shop-primed and touch-up painted.
- C. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. Allow sufficient time between successive coats to permit proper drying. Do not re-coat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.
- D. Application Procedures: Apply paints and coatings by brush or roller on piping, insulation, and electrical conduits, and by spraying on metal decking, in accordance to the manufacturer's directions.
1. Brushes: Use brushes best suited for the material applied.
 2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.
- E. Minimum Coating Thickness: Apply materials no thinner than the manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- F. Mechanical and Electrical Work: Painting mechanical and electrical work is limited to items exposed in mechanical equipment rooms and in occupied spaces.
1. Mechanical items to be painted include, but are not limited to, the following:

- a. Piping, pipe hangers, and supports.
 - b. Supports.
 - c. Accessory items.
- 2. Electrical items to be painted include, but are not limited to, the following:
 - a. Conduit and fittings.
- G. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime-coated by others. Re-coat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with specified requirements.

3.4 FIELD QUALITY CONTROL

- A. The Owner reserves the right to invoke the following test procedure at any time and as often as the Owner deems necessary during the period when paint is being applied:
 - 1. The testing agency will perform appropriate tests for the following characteristics as required by the Owner:
 - Quantitative materials analysis.
 - Abrasion resistance.
 - Apparent reflectivity.
 - Flexibility.
 - Washability.
 - Absorption.
 - Accelerated weathering.
 - Dry opacity.
 - Accelerated yellowness.
 - Re-coating.
 - Skinning.
 - Color retention.
 - Alkali and mildew resistance.
 - 2. If test results show material being used does not comply with specified requirements, the Contractor may be directed to stop painting, remove noncomplying paint, pay for testing, repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are incompatible.

3.5 CLEANING

- A. Cleanup: At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
 - 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.6 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Owner.
- B. Provide “Wet Paint” signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.7 INTERIOR PAINT SCHEDULE

- A. General: Provide the following paint systems for the various substrates, as indicated.
 - 1. Ferrous Metal:
 - a. Semi-gloss Enamel Finish: Two coats over primer with total dry film thickness not less than 2.5 mils.
 - 1) Primer: Synthetic, quick-drying, rust-inhibiting primer.

Devoe:	14920 Bar-Ox Quick Dry Metal Primer, Red.
Moore:	Ironclad Retardo Rust-Inhibitive Paint #163.
PPG:	6-208 Red Inhibitive Metal Primer.
S-W:	Kem Kromik Metal Primer B50N2/B50W1.
 - 2) Undercoat: Interior enamel undercoat.

Devoe:	Latex Enamel Undercoat.
Moore:	Moore’s Latex Enamel.
PPG:	6-6 Speedhide Quick-Dry Enamel Undercoater.
S-W:	Pro-Mar Latex Enamel Undercoater B49W200.
 - 3) Finish Coat: Interior, semi-gloss, odorless, Latex enamel.

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Devoe: Latex Semi-gloss Enamel.
Moore: Moore's Latex Satin Impervo Enamel.
PPG: Latex Semi-gloss Enamel.
S-W: Latex Semi-gloss Enamel.

2. Cotton or Canvas Covering over Insulation:

a. Flat Latex Emulsion Size: Two coats. Add fungicidal agent to render fabric mildewproof.

1) First and Second Coats: Interior, flat, latex-based paint.

Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
Moore: Regal Wall Satin #215.
PPG: 50-35 Latex Ceiling Paint.
S-W: Classic 99 Wall and Trim Paint A27W10.

END OF SECTION 099100

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. Contractor shall make all connections to existing domestic water and gas piping within the building where indicated.

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 Owner 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. Verify all utility connections before commencing work.
- C. 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
Roof Hydrant
Backflow Prevention Devices

- B. Submit shop drawings on the following:

Roof Hydrant

- 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 Owner 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 and silver solder underground.
- B. Press Connector Fittings (as an Option):
 - 1. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and NSF/ANSI Standard (NSF 61). Sealing elements for press fittings shall be factory installed EPDM.
 - 2. Press-connected fittings 1/2" – 2" press end shall have a leak-before-press feature, which assures leakage from inside the system past the sealing element of an unpressed connection. Fittings 2-1/2" – 4" press end shall have a factory installed means for visual inspection of completed press. Copper press fitting joints shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark in the tubing to ensure the tubing is fully inserted in the fitting. The joints shall be pressed using the pressing tool and jaws or jaw set, approved by the fitting manufacturer. Fitting installer shall be trained by the fitting manufacturer's factory representative.
 - 3. Press connected fittings shall be by ELKHART PRODUCTS CORP., NIBCO, VIEGA or approved equal.

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

2.3 VALVES

- A. Provide valves on piping as indicated and as required to isolate fixtures and 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. Valves on copper water piping, up to and including 2", shall be bronze or brass. 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.

<u>Type</u>	<u>Size</u>	<u>Catalog Number</u>
Ball	2" and smaller	S-585-80-LF

- C. Reduced Pressure Principle Backflow Preventers: (No Lead)

<u>Size</u>	<u>Catalog Number</u>
2" and smaller	975 XL2-S w/strainer where indicated

Provide air gap fitting on both models. WILKINS catalog models indicated, or approved equal.

2.4 FIXTURES AND EQUIPMENT

- A. Roof Hydrant shall be WOODFORD MFG. CO. Model SRH-MS with internal reservoir and double-check backflow preventer or approved equal by PRIER or HOEPTNER PRODUCTS.

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 Owner.

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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(s) 21, 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 2020	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, 2021 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 and structural plans and work in order to avoid omissions and to eliminate any interference. Report in writing discrepancies, if found, to the Engineer as soon as possible after discovery.

1.5 WORKMANSHIP

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

1.6 CUTTING

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

1.7 APPROVAL OF MATERIALS, FIXTURES AND EQUIPMENT

- A. See Specification Section 013300 "Submittal Procedures", for shop drawing submittal procedures. Within 30 days after award of the Contract and before any purchases are made, submit for approval a complete list of materials, fixtures and equipment proposed, together with names of manufacturers and catalog numbers for each Specification Section. Furnish other detailed information where directed. No consideration will be given to partial lists submitted from time to time. Approval of materials shall be based on manufacturer's published ratings. Materials, fixtures and equipment listed which are not in accordance with specified requirements shall be rejected. Contractor shall make resubmission of items not approved within 30 days from date of rejections. Submission shall be complete with description, ratings, dimensions and related items and any additional information required by the Engineer.
- B. Materials and equipment shall be new, conforming to these Specifications.
- C. Two or more units of same class of equipment shall be product of single manufacturer; however, component parts of system need not be product of same manufacturer.
- D. Mechanical design has given full consideration to space requirements for equipment specified. Contractor is responsible for selecting equipment that will be accommodated by this space. Equipment not conforming to space allotted shall be rejected.
- E. Mechanical design has given full consideration for electrical requirements for equipment. Contractor is responsible for selecting equipment that will be accommodated by the electrical design indicated. Equipment not conforming to the electrical design provided under Division 26

is the Contractor's responsibility. All electrical changes required to accommodate the equipment provided shall be furnished and installed by the Contractor without change in Contract price or time of completion. This shall include but not be limited to wiring, conduit, circuit breakers, disconnect switches, starters and controllers.

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

1.8 EQUIPMENT DESIGN

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

1.9 SUPERVISION

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

1.10 NOTICES AND FEES

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

1.11 RECORD DRAWINGS

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

1.12 OPERATION AND MAINTENANCE MANUALS

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

1.13 OWNER'S TRAINING

- A. Upon completion of work and at a time designated by the 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 video recorded by the Contractor and provided in electronic format.

1.14 WARRANTY-GUARANTEE

- A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of materials and workmanship for a period of 12 months from date of Final Completion.
- B. Contractor shall service the systems for 12 months from date of Final Completion. Such service shall include all emergency services and adjustments, except cleaning/changing of filters. Adjustments and repairs to equipment shall be made by the original equipment manufacturer (OEM). Third party service agencies are not acceptable for making repairs or adjustments to equipment during the warranty period.
- C. The equipment manufacturer and Contractor shall provide a one-year material, labor and refrigerant warranty on all compressors. In addition, the manufacturer shall provide a material only warranty on all compressors for a period of 5 years total, beginning at the date of Final Completion.
- D. Contractor shall be responsible for all maintenance, repair and servicing of mechanical equipment during the construction and warranty period as required by the equipment manufacturers and identified in the Operation and Maintenance Manuals. This shall include all routine maintenance, such as greasing of bearings, adjustment/replacement of belts, cleaning of coils, cleaning of strainers, water treatment adjustments, calibration of controls and other routine maintenance items that may be unique to each piece of equipment. This shall also include repair and replacement of any malfunctioning or damaged parts. In addition, this shall include changing filters on a bi-weekly basis through award of Substantial Completion and on a monthly basis during the warranty period. Where pre-filters and final filters are used in a system, the final filters shall only require replacement once, at the end of the warranty period, as long as the pre-filters have been changed as specified. Upon the Owner's observation that this work is not being performed by the Contractor, the Owner will arrange to have these services performed and shall deduct the associated costs from the contract amount or back charge the Contractor for services performed. Monthly service logs shall be forwarded by the Contractor to holders of the operation and maintenance manuals. Contractor shall respond within 24-hour notification by Owner or General Contract.
- E. Refer to Specification Section 017836 "Warranties And Bonds" for additional requirements.

1.15 WELDER'S CERTIFICATIONS

- A. Submit welder's certifications to the Engineer/Architect for approval prior to any welding taking place.

1.16 TEMPORARY HVAC REQUIREMENTS

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

- B. Temporary Cooling/Heating/Dehumidification equipment shall be provided for each of the following spaces:
 - 1. Library served by RTU-10 & IDF Room adjacent to the Library.

PART 2 - PRODUCTS

2.1 STEEL PIPE FITTINGS

- A. Welding fittings shall be carbon-steel butt welding 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”, “Sokolets” and “Threadolets” may be used for branch connections when the diameter of the branch connection does not exceed 50% of the diameter of the main.

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

- A. Provide pipe sleeves, hangers, supports and duct supports. Contractor shall be responsible for proper and permanent location. Pipe and duct shall not be permitted to pass through footings, beams, or ribs, unless indicated and/or approved. All piping passing through walls shall be sleeved and insulation shall run continuously through sleeve.
- B. 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 trapeze hangers on pipes running parallel and close together. Support vertical runs of pipe by clamps or collars spaced not over 20 feet apart or as required. 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.
- C. Hang all horizontal overhead runs of pre-insulated refrigerant pipe with a pipe shield as manufactured by EATON B-LINE, series SNAP’N SHIELD 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.
- D. Refrigeration 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", "ROL-06" for pipe sized 4" through 6". 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.

- E. 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.
- F. In areas supported by steel beams, secure hanger rods directly to beams.
- G. Support vertical lines from lowest story with base fittings set on concrete or brick pier or by hangers and supports where directed.
- H. Provide galvanized steel shields or protection saddles to protect insulation at area of contact with hangers and supports. Where shields are used on pipes 1-1/2" and larger, provide insulation inserts at points of hangers and supports. Refer to Specification Section 230700 "Mechanical Insulation", for details.
- I. Support and fasten fixtures and equipment in an approved manner.
- J. Ductwork shall be supported in accordance with SMACNA, HVAC Duct Construction Standards, unless otherwise noted or indicated. Ductwork shall be supported using threaded rod or solid metal strap as required by SMACNA. No other materials, such as perforated metal strap, or cloth strap, are acceptable. Wire may be used to hang round duct smaller than 10"; however, solid metal strap shall be used to wrap around duct. Wire shall not be used for rectangular duct or round duct larger than 10".

2.3 DUCT AND PIPE PENETRATIONS THROUGH FLOORS, WALLS AND CEILINGS

- A. Fit exposed pipes passing through floors, finished walls, or finished ceilings with escutcheon of chromium-plated cast-brass plates on chromium-plated pipe, nickel-plated steel plates on ferrous pipe, or copper tubing. Plates shall be large enough to completely close hole around pipes and conceal pipe sleeves and shall be round, with least dimension at least 1/2" larger than diameter of pipe and insulation. Secure plates in an approved manner.
- B. Fit ductwork passing through floors, walls, or ceilings with 22-gauge galvanized sheet-metal sleeves. Sleeves shall be large enough to completely close hole around duct and shall be at least 1/2" larger than outside dimensions of duct and insulation. Provide flanges on both sides of penetrations to cover the wall edge. For uncovered ducts, sleeves shall be of same material as duct. Secure sleeves and flanges in an approved manner.

- C. Fit ductwork passing through roof membrane with a 12" insulated 18-gauge galvanized roof curb. Provided flashing, counter flashing at duct and roof penetrations.
- D. Ducts passing through fire walls, smoke partitions, fire partitions, or floors shall be sealed with a UL rated system appropriate for the specified fire rating.
- E. 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.

2.5 DIELECTRIC CONNECTIONS

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

2.6 ELECTRICAL WORK FOR EQUIPMENT UNDER MECHANICAL SYSTEMS

- A. All non-integrated motor controllers and starters serving equipment installed under Division 23 Sections shall be furnished under those Sections and shall be turned over to Electrical Contractor, for installation by Electrical Contractor. Controllers shall be equipped with all auxiliary contacts, poles, or devices necessary to permit interlocking and control required.
- B. Fractional horsepower motors 1/2 HP and below shall be single-phase, 60 cycles, 120V; motors larger than 1/2 HP shall be 3-phase, 60 cycles, of voltages indicated on the electrical drawings and conforming to the electrical service, except where indicated otherwise. Motors shall conform to latest NEMA requirements.
- C. All electrical power wiring required for equipment installed under Division 23 Sections shall be provided under Division 26 Sections with all necessary approved wiring diagrams and guidance provided under Division 23 Sections, with the exception of power wiring to Automatic Temperature Control panels which shall be provided by the Automatic Temperature Control Contractor.
- D. Raceways shall be 1/2" minimum. All wiring in rooms with exposed structure or in inaccessible ceiling and walls shall be installed in conduit. Label the front face of the cover on each junction box with indelible black marker indicating the number of each circuit contained in or running through the box. In areas where exposed construction is the final finished condition and conduit and junction boxes are called out to be painted, label the inside face of the covers.

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- 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. All power wiring for the temperature control system shall be fed from an emergency panel served by the emergency generator where emergency power is available on site. Accessory control wiring including, but not limited to interlock wiring for electric damper actuators (separate from DDC systems), and remote equipment sensors shall be provided and installed by the Plumbing, Mechanical and Automatic 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. Manual starters shall be manual single-, double-, or three-pole type designed for flush or surface mounting, with overload protection in each phase.
- H. Starters for motors under automatic control shall have built-in "hand-off-auto" selector switch.
- I. 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.
- J. 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.
- K. Auxiliary 120-Volt contacts shall be provided to give control and interlocking as required or as indicated.
- L. Where control voltages are different from motor voltages, a control-voltage transformer shall be provided as a part of the starter.
- M. 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.
- N. The Automatic Temperature Controls Contractor shall be responsible for providing circuit breakers and power wiring and conduit from electrical panels installed under Division 26 to Automatic Temperature Controls panels. All electrical work shall be in accordance with appropriate codes and Division 26 specifications.
- O. 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 28. 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.

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

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

2.7 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 WALL, PARTITIONS AND CEILING ACCESS DOORS

- A. The Contractor shall furnish and the General Contractor shall install access doors with lock where required, style necessary for surface in which placed, sizes as indicated or required for access to equipment, valves, dampers, filters, duct smoke detectors and all other devices requiring access. Access doors shall be at least 18" x 18".
1. Access doors in ceilings shall be ACUDOR "UF-5000" or equal. Finish shall be prime coat steel.
 2. Access doors in walls shall be ACUDOR "UF-5000" or equal. Finish shall be Type 304 stainless steel with #4 satin polish.
- B. Access doors shall have same fire rating as ceiling, floors, walls and partitions in which installed.
1. Access doors in fire-rated ceilings shall be ACUDOR "FWC-5015" or equal. Finish shall be satin coat steel.
 2. Access doors in fire rated walls shall be ACUDOR "FC-5015" or equal. Finish shall be satin coat steel.

2.9 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.

2.10 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. Weld expansion loops using long-radius ells. Make changes in pipe sizes with reducing fittings.
- D. Pipe outlets of vent valves, safety valves, drip pans, overflow drains, condensate drains, backflow preventers and other drain points to floor drain unless otherwise indicated. Gages, thermometers and related items shall be carefully leveled. Thoroughly clean and flush all new and existing piping in presence of the Engineer, as installed and before automatic vents are installed.
- E. Unless otherwise indicated, connections to equipment shall be as shown by manufacturer's data. Make piping connections to equipment with unions or flanged connections arranged so that equipment can be dismantled without disturbing the piping installation. Unions shall be accessible after building is complete. Provide valves to isolate equipment for service or removal.

- F. Run horizontal water piping with pitch of at least 1" in 40'-0" and arrange to drain to minimum number of low points. Equip low points with drain valves and hose nipples not smaller than 3/4". Eccentric reducing fittings or eccentric reducing couplings must be installed where indicated or as required to bring bottoms of mains in line and prevent pockets. Pitch closed loop water piping to vent at high points. Provide a manual air vent ball valve at all high points in the piping system.
- G. Close pipe openings with caps or plugs during installation. Cover 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.
- 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.
- K. All copper pipe joints shall be made with fittings. Formed bell & spigot couplings and mechanical "T" formed joints are not acceptable.

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. Fasten wall-mounted or ceiling-hung equipment to building structures or inserts as approved.
- C. Where concrete foundations or pedestals are indicated or required, use concrete mix, reinforcement where required and methods as specified under Section 033000 "Cast-In-Place Concrete".
- D. Where floor is waterproofed, construct foundation so that anchor bolts will not pierce waterproofing.
- E. Finish exposed parts of concrete foundation with cement mortar. Fill voids, trowel smooth, bevel edges and corners to make neat appearance.
- F. 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.
- G. 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 Owner.
- B. If such objectionable noise or vibration should be produced and transmitted to occupied portions of building by apparatus, piping, ducts, or other parts of mechanical and electrical work, make necessary changes and additions as approved, without extra cost to the Owner.
- C. Isolators shall prevent, as far as practicable, the transmission of vibration, noise, or hum to any part of building.
- D. Isolators shall suit vibration frequency to be absorbed. Provide isolator units of area and distribution to obtain proper resiliency under load and impact.

3.6 CONCRETE PADS

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

3.7 FLASHING

- A. Provide cap flashing for roof-mounted fans, 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. 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.
- F. Equipment not designed for exterior installation (i.e., indoor split system units, cabinet exhaust fans, air handling units, 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.
- G. Equipment suitable for exterior installation (i.e., rooftop units, roof-mounted exhaust fans, etc.) shall not be delivered to the job site until it is ready to be installed in its permanent location.

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

- A. The equipment manufacturer shall furnish a factory-trained and certified service technician without additional charge to start the HVAC equipment. This individual's certifications shall be submitted as a shop drawing along with the equipment and shall be reviewed and approved by the Engineer. Unit manufacturers shall maintain service capabilities no more than 100 miles from the job site.
- B. The HVAC equipment to be started by the manufacturer's certified technician shall include:
 - 1. Boilers
 - 2. Pump
 - 3. Packaged rooftop air conditioning units
 - 4. Air handling units
 - 5. Split system air conditioning condensing units
 - 6. Computer room air conditioning units
- C. The manufacturer shall furnish complete submittal wiring diagrams of the HVAC equipment as applicable for field maintenance and service.
- D. Start-up sheets on all equipment shall be submitted and reviewed by the engineer. An approved copy shall be included in the final TAB report. If required, this same representative shall be made available to review the startup sheets onsite with the Engineer and Owner.

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

- A. Provide the TAB Agency a full set of Contract Documents (drawings and technical specifications), all manufacturers' approved submittal data and copies of revised data as soon as possible.
- B. Ensure that a current TAB Engineer's certification certificate is kept on file.
- C. Ensure all systems have been installed and are in 100% working order before the TAB Engineer is called to the job site, including but not limited to ductwork, piping, terminals, electrical and ATC. The Contractor shall verify that each item of the Pre-TAB Checklist (see Appendix A) has been completed and shall deliver a signed copy of the Pre-TAB Checklist to the Owner's Representative and the TAB Agency attesting that the project is complete and ready for TAB work to begin.
- D. Ensure that all ductwork requiring SMACNA – ADLTM duct leakage testing has been tested in the presence of the TAB Engineer and Owner's Representative and has met the referenced requirements.
- E. Provide adequate access to all points of measurement and adjustment and ensure that all dampers operate freely.
- F. Provide a factory representative for all major pieces of equipment as requested by the TAB Agency to assist in operation and performance verification of equipment.
- G. Cooperate with the TAB Agency to help operate and adjust the control systems directly related to TAB work and provide any specialties required to make such adjustments.
- H. Carefully review the drawings and Specifications for the various systems noting all facilities incorporated in the design for purposes of adjusting and balancing. Should it be deemed necessary to provide additional dampers, baffles, valves, or other devices which would aid in the required adjusting and balancing, same shall be provided by the installing contractor.

3.11 CLEANING, PAINTING AND IDENTIFICATION

- A. Remove from site excess material, equipment protection, etc. Thoroughly clean piping, hangers, equipment, fixtures and trimmings and leave every part in perfect condition ready for use, painting, or insulation as required.
- B. Paint exterior surfaces of equipment supports and other ferrous metal work, except that which is galvanized, with one coat of RUSTOLEUM damp-proof red primer, or approved equal.
- C. Exposed piping and equipment in mechanical equipment rooms and mechanical mezzanines shall be completely color code painted under this Section. Insulated piping shall be color coded under Section 230700 "Mechanical Insulation" using colored PVC jackets matching the colors listed in this Section. Finish painting shall conform to requirements of Section 099100 "Painting". Color

code shall be as follows (SHERWIN-WILLIAMS names and numbers are given for reference of colors):

Gas	Safety Yellow (SW-4084)
Heating Hot Water Supply and Return	Safety Orange (SW-4083)
Ductwork, Plenums, O.A. Return Plenums	White (Extra White))

- D. Finish painting of exposed piping, ductwork, equipment and insulation in finished spaces shall be done under Section 099100 "Painting".
- E. Water piping service and flow direction shall be indicated with outdoor grade 3.2 mil thick high gloss adhesive backed vinyl labels which identify the service by name (not initials) and the flow direction by arrows. Provide labels similar to Brimar, EZ Pipe Markers with arrow banding tape wrapping the pipe 360°. Labels shall be used wherever piping is exposed, except in finished spaces, at all unit connections and at 25-foot intervals for concealed piping located above accessible ceilings. Label and arrow heights shall be proportional to pipe sizes as follows:

Insulated and Un-Insulated <u>Pipe Size</u>	<u>Label</u> <u>Heights</u>
Up to 1"	1"
1-1/4" to 2"	2"
2-1/2" to 4"	3"
4" and above	4"

- F. 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".
- G. 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.
- H. Provide seals, signs and tags on fire protection equipment at designated locations per NFPA.
- I. Provide color-coded identification dots affixed to the ceiling grid for all new and existing 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, variable frequency drives, control panels, boilers, chillers, fans, VAV boxes, pumps, air-handling units, and thermostats.

- B. Labels shall be machine engraved, laminated, 1/8" thick, Bakelite, nameplate type. Labels shall be black faces with white letters.
- C. Labels shall have 1/4" high letters.
- D. Labels shall be rigidly attached using rivets or screws. Adhesive backing is not acceptable.
- E. Thermostat labels shall be a self-adhesive type. Labels shall identify the equipment served by the thermostat.

3.13 EQUIPMENT INVENTORY

- A. Provide a complete equipment inventory for all Mechanical, 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 (NEW AND EXISTING)

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.

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4. All ductwork and connections of duct to air terminals have been checked and no visible or audible leakage exists.
5. Fans are rotating in correct direction. Fans have been lubricated. Drive pulleys are aligned and belt tension is correct. Setscrews are tight securing keys into key-ways. Fan wheels turn freely and are balanced. Belt guards are in place.
6. Vibration isolators and flexible connectors have been installed where required. With fans in operation, there is no excessive vibration of fan assemblies or ductwork.

I, _____ an authorized representative of
(Signature and Title)

(Company)

attest that all items contained in the above Pre-Tab Checklist have been completed

and verified as of this date:_____.

APPENDIX B

Equipment Inventory Template

Project Name: **Menchville High School HVAC System Replacement**

Project Address: **275 Menchville Road, Newport News, VA 23602**

Description of Item: _____
(i.e., Air Handling Unit, Ductless Split System, etc.)

Classification:

- ☐ HVAC
☐ Plumbing
☐ Fire Protection

Building: _____

Equipment Location (Room Number): _____

Date Purchased: _____

Date Placed in Service: _____

Original Cost: _____

Life Expectancy (years): _____

Estimated Replacement Date: _____

Estimated Replacement Cost: _____

Manufacturer: _____

Model/Serial #: _____

END OF SECTION 230100

SECTION 230500 - HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 "Mechanical General Provisions" apply to this Section.
- B. Refer to Specification Sections 230900 "Automatic Temperature Controls" and the Control Diagrams on drawings for additional requirements and coordination between equipment and controls.

1.2 WARRANTY-GUARANTEE

- A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of material and workmanship for a period of 12 months from date of Substantial Completion of the building. Refer to Section 230100 for additional warranty period responsibilities.

1.3 SUBMITTALS

- A. Prior to fabrication of any ductwork, Mechanical Contractor shall prepare and submit for review and approval 1/4" scale ductwork shop drawings. Drawings shall indicate all equipment locations and double line ductwork layout. Drawings shall be coordinated with existing conditions and Architectural, Structural, Sprinkler and Electrical Drawings.
- B. 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.

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". Alternates are CLEAVER-BROOKS "CLEARFIRE" and AERCO "BENCHMARK". 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 and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 30,000 to 40,000 Btu's per tube. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger design. Cast iron, aluminum, or condensing copper tube boilers will not be accepted.
4. Condensate Collection Basin: Fully welded 316L stainless steel.
5. Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.
6. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 6.5 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than 157 gallons.
7. Burner: Natural gas, forced draft single burner premix design with an upper and lower chamber supplied by individual combustion systems. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall have an independent laboratory rating for Oxides of Nitrogen (NOx) to meet requirements of South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2.
8. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.
9. Gas Train: The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of the following minimum turndowns:

Model	Turndown	Minimum Input	Maximum Input
FB 25601	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 1/2 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: 1-1/2" and 3,075 MBH
 - 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 Drain Dilution Tank and Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.
14. Controls:
 - a. Refer to Specification 230900 Automatic Temperature Controls or control diagram on drawing.
 - b. Boiler controls shall feature a standard, factory installed 8" LCD screen display with the following standard features:
 - 1) Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
 - 2) Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
 - 3) Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
 - 4) Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.

- 5) Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
 - 6) PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
 - 7) Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
 - 8) Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
 - 9) Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
 - 10) Night setback: Boiler shall be programmed to reduce the space heating temperature set point during a certain time of the day.
 - 11) Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps shall turn off when the boiler water temperature rises above 43 degrees.
 - 12) BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
 - 13) Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.
- c. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:
- 1) Lead lag:
 - 2) Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.
 - 3) Front end loading:
 - 4) Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.
- d. Boiler operating controls shall include the following devices and features:
- 1) Set-Point Adjust: Set points shall be adjustable
 - 2) Operating Pressure Control: Factory wired and mounted to cycle burner.

- 3) Sequence of Operation: Electric, factory-fabricated and factory-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 35 deg F outside-air temperature, set supply-water temperature at 160 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 100 deg F.
 - e. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - 1) High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
 - 2) Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
 - 3) Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - 4) High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
 - 5) Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
 - 6) Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
 - 7) Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.
 - f. Building Automation System Interface: Factory installed BACnet gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.
15. 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.
16. Source Quality Control:
- a. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
 - b. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Boiler Vent System:

1. Vents shall be Saf-T Vent CI Plus as manufactured by HEATFAB, INC., SCHEBLER, JEREMIAS EXHAUST SYSTEM, Z-FLEX, SECURITY CHIMNEY, or approved equal.
2. All products furnished under this Section shall conform to the requirements of The National Fuel Gas Code, NFPA-54, where applicable and shall comply with and be listed to UL1738, Standard for Venting Systems for Gas-Burning Appliances, Category II, III and IV. Components coming in direct contact with products of combustion shall carry the appropriate UL listing mark or label.
3. The vent shall be of the double-wall, factory-built type for use on condensing appliances or pressurized venting systems serving Category II, III, or IV appliances or as specified by the equipment manufacturer. Maximum temperature shall not exceed 550°F (288°C).
4. Vent shall be listed for an internal static pressure of 6" w.g. and tested to 15" w.g.
5. Vent shall be constructed with an inner and outer wall, with a 1" annular insulating air space.
6. The inner wall (vent) shall be constructed of AL29-4C, superferritic stainless steel, .015" thickness for 6"-12" diameters and .024" thickness for 14"-24" diameters.
7. The outer wall (casing) shall be constructed of aluminized steel or 430 stainless steel, .018" thickness for 6"-12" diameters and .024" thickness for 14"-24" diameters.
8. Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of the inner and outer walls.
9. All vent parts exposed to the weather shall be stainless steel.
10. All supports, wall penetrations, terminations, appliance connectors and drain fittings, required to install the vent system shall be included.
11. Wall penetration pieces shall be UL listed and provided by the vent manufacturer.
12. All inner vent connections shall be secured by means of profiled connector bands with gear clamp tighteners. Joints shall be sealed with P077 Sealant.
13. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.
14. Vent shall terminate in accordance with installation instructions and local codes.
15. Clean all breechings of dust and debris prior to final connection to appliances.
16. Contractor shall pressure test the Breeching Systems as recommended by the manufacturer to demonstrate System integrity. Make necessary adjustments as required to meet the manufacturer's recommendations for System airtightness.

2.2 REFRIGERATION (NOT USED)

2.3 AIR HANDLING EQUIPMENT

A. Exhaust Fans:

1. Fans shall be size, type, and have capacity as indicated on drawings. GREENHECK, LOREN COOK, or approved equal.
2. Fans shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. Fan air performance ratings shall be based on tests conducted in an AMCA registered laboratory for AMCA 210 air performance testing. The Test Standard used shall be ANSI/AMCA Standard 210-85, ANSI/ASHRAE Standard 51-1985, "Laboratory Methods of Testing Fans for Rating." All sizes must be tested, calculations to other sizes not acceptable. Fan sound

performance shall be based on tests conducted in an AMCA registered laboratory for AMCA 300 Sound Performance Testing. The Test Standard used shall be AMCA 300 "Reverberant Room Method for Sound Testing of Fans." All sizes must be tested, calculations to other sizes are not acceptable. Air or Sound Test results are to be included in submittal.

3. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
4. Provide solid-state speed controls for all direct drive fans.
5. All fans shall be statically and dynamically balanced.
6. Install as required for quiet operation.
7. Motor shall be a DC electronic commutation type motor (ECM) specifically designed for fan applications unless otherwise noted.
8. Downblast power roof ventilators:
 - a. Downblast power roof ventilators shall have aluminum housing, backward-inclined aluminum fan wheel, gravity-type back-draft dampers, bird screen, aluminum curb cap with pre-punched mounting holes, aluminum rub ring, motor isolated shock mounts, corrosion-resistant fasteners, lifting lugs and factory-wired NEMA 1 toggle disconnect switch. Provide direct or belt drive as indicated. Shaft shall be mounted in ball bearing pillow blocks. Bearings shall have grease fittings. Provide adjustable pulley and motor plate on belt drive units.
9. Kitchen Exhaust Fans:
 - a. Fan shall be size, type and have capacity as indicated on drawings. GREENHECK, LOREN COOK, ACME or approved equal.
 - b. Kitchen hood roof exhaust fans shall be upblast centrifugal belt driven type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. Windbands shall have a rolled bead for added strength and shall be joined to curb caps with a leakproof, continuously welded seam.
 - c. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
 - d. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 - e. Motor pulleys shall be adjustable for final system balancing. A disconnect switch shall be factory installed a wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.
 - f. The fan shall be UL 762 listed for grease removal.

- g. Fan shall be mounted on existing curbs. Where dimensions of fan bases do not match curb dimensions provide galvanized steel adapters. Provide curb extension if required to meet minimum discharge height of 40 inches.

B. Rooftop Units with Energy Recovery (RTU-1, 2, 5, 6 AND RTU-8 THROUGH RTU-17)

1. Work Included:

- a. This specification is based on an Energy Recovery Model as manufactured by ANNEXAIR INC. Alternative manufacturers including ENGINEERED AIR AND INNOVENT will be considered provided the unit meets the specifications, dimensional and performance requirements as listed in the plans and specifications.
- b. The units shall be installed in strict accordance with the specifications. Units shall be complete with all components and accessories as specified. All units shall be factory assembled, internally wired, and 100% run tested to check operation, fan/blower rotation and control sequence before leaving the factory. Wiring internal to the unit shall be numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance with ANSI-UL 1995/CSA C22.2 No.236.
- c. Equipment start-up and project inspection shall be performed by qualified factory trained representatives.

2. Quality Assurance:

- a. All units shall be factory run tested before shipping. A proof copy of the test shall be placed in the unit electrical power & control panel.
- b. Units shall bear the ETL label, tested in accordance to UL 1995. Electrical components shall be UL listed.
- c. Fans shall be tested in an AMCA certified laboratory; insulation shall comply with NFPA 90A.
- d. Coils shall be tested in accordance to AHRI 410.
- e. Energy recovery exchangers shall be in accordance to AHRI 1060, "Rating Air-to-Air Energy Recovery Equipment".
- f. Filters shall be tested in accordance to ASHRAE 52.
- g. Units that shall be shipped in sections shall be reassembled by factory authorized personnel and inspected.

3. Construction:

- a. Thermo-Composite Panels (with thermal break frame):
 - 1) The unit housing shall be no-through metal with 2" Thermo-Composite and foam panel construction - interior and exterior or an all-aluminum 4" Foam thermal break construction - interior and exterior. Thermal break construction using a gasket to insulate two panels is not an acceptable equivalent to a no-through metal constructed casing. No-through metal construction will be inherent to all the component construction in the assembly.
 - 2) All panels and access doors shall be double wall construction with R14 foam insulation for every 2" of construction. Any insulation incorporating CFCs or HCFCs in its construction is strictly prohibited from this application.

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- 3) Unit casing will have no exterior condensation at interior AHU temperatures down to 42.5F while unit exterior conditions are maintained at 95 F dry bulb / 85 F wet bulb. The air handling unit manufacturer general construction shall be tested to demonstrate the thermal performance of the unit casing. The test shall include placing the entire test unit in a climate-controlled environment and exposing the unit to the conditions mentioned previously. If the manufacturer does not have access to such equipment, an independent testing agent must be hired to transport the test unit to a qualified test facility and perform the test at the expense of the manufacturer. Inability to provide this option to the engineer will make the manufacturer ineligible to bid on this project. The unit housing shall be constructed from a frame, base and panel assembly. Unit shall be completely factory assembled and shipped in one-piece as shown on drawings.
- 4) The panels shall be tested in accordance with SMACNA and ASHRAE 111 to have a deflection of no more than $L/700$ at 10'' and withstand air pressures up to 8'' w.c. with less than 1% leakage. Fire resistance of the panel will be in compliance with UL 94 rated at 5VA; and a flame spread / smoke development in compliance with UL 723 ASTM E84 Class 1 rating.
- 5) Thermo-Composite or aluminum panels shall be provided for the entire unit construction, including but not limited to, walls, doors, floors, roof, interior partitions, and electrical compartment. Panels shall be non-load bearing type.
- 6) The frame shall consist of anodized extruded aluminum profiles which incorporates a thermally broken construction; welded together for reinforcement and insulated for superior thermal performance.
- 7) Base structure shall be fully welded G-90, painted exterior, and have integral lifting lugs which can be removed once the unit is installed.
- 8) All roof and side wall seams shall be positively sealed to prevent water and air leakage. The OA compartment shall have 1'' PVC drain extended to exterior of unit
- 9) Access doors shall be provided to all major components to facilitate quick and easy access. Access doors will be made from the same material as the unit casing and shall incorporate thermal break construction. Fan access door(s) shall have Allegis type handles, with one handle interlinking multiple latches and threaded insert fastening handles for all remaining doors. If access doors do not open against unit operating pressure, provide safety latches that allow access doors to partially open after first handle movement and fully open after second handle movement. Removable panels provided for equipment pull out for coil(s), and air to air heat exchanger section(s) shall have key tooled threaded insert fasteners. Hinges shall be Nylon hinge type designed to open 180 degrees.
- 10) Unit shall have the entire exterior finished with a PVDF coating designed for UV resistance. Panels shall be painted ANNEXAIR standard color Pantone Cool Gray 1C. Panels shall pass ASTM B117 3000-hour salt fog resistance test and ASTM D4585 3000-hour moisture condensation resistance test. In addition, paint must meet AAMA 620-02 standard for color, chalking, gloss retention, and abrasion resistance.
- 11) The air handler unit casing shall be provided with a lifetime warranty against corrosion resistance under normal use.

b. Weather Hoods:

- 1) The outdoor intake weather hood shall be completely constructed in aluminum for superior corrosion resistance. Painted galvanized hoods shall not be acceptable due to its susceptibility to corrosion.
- 2) The hood shall ship loose for field installation by the installing contractor.
- 3) The outdoor air hood shall be designed with a 4" extruded aluminum louver, bird screen and a plenum enclosure with drain holes. The louver blades shall be drainable type with a maximum 40-degree angle and curved with integral rain baffle. The louver design shall not allow more than 0.01 oz/ft² water penetration when tested in accordance to AMCA 500. The pressure drop of the complete hood assembly shall not exceed 0.01" wc at a maximum 500 fpm face velocity.

c. Exhaust Air Louver:

- 1) The exhaust air outlet louvers shall be 2" extruded aluminum, with non-restricting blade design and bird screen.

d. Enthalpy Wheel:

- 1) The enthalpy wheel shall recover both sensible and latent heat.
- 2) The matrix shall be a minimum of 8" thick to achieve optimal performance and be constructed from a corrugated aluminum alloy. The corrugation shall be uniform to obtain minimum pressure drops through the wheel.
- 3) All wheels will be one piece construction standard up to 85" diameter (size 12), and segmented construction above 96" diameter (size 16).
- 4) Wheels with varying flute sizes are not acceptable. Wheels with non-metallic matrices will not be considered for this application.
- 5) The media shall be specifically treated and coated with Silica gel desiccant to assist and enhance latent heat transfer.
- 6) The wheel bearing shall be permanently sealed, and press fitted into the wheel hub for wheel sizes up to 96" diameter, and greaseable bearings for larger than 96" diameter. The seal shall be made from a dual band ultra-high molecular weight polyethylene and be self-lubricating, wear resistant, and airtight against prolonged use. Seals shall be full contact compression type, on both sides of the wheel to ensure minimal leakage. Specially designed stainless steel clips are used to position the seal across the face of the wheel. Any seal that is non-contact is not to be considered a seal and will not be acceptable. Labyrinth type seals do not operate properly under different air stream pressures therefore shall not be acceptable in any circumstances.
- 7) Drive system shall be operated by a fractional horsepower TEBC motor (maximum 1 HP), VFD micro drive, pulley and V-belt. Belts shall be made of multi-link high-tech urethane/polyester composite. An access panel shall be provided for maintenance on the drive system.
- 8) A double purge sector (2 x 5°) shall be factory installed to reduce cross contamination to under 0.04%.
- 9) Frost control prevention shall be provided by the unit manufacturer and accounted for if outdoor air temperatures are below 10°F at equal airflows and

return relative humidity below 30%. Frost control shall be accomplished by a variable speed drive and controlling the leaving air condition of the exhaust air. Other methods of frost control will not be considered for this application.

- 10) Wheel speed shall not rotate faster than 20 RPM (min 0.7rpm). Any rotational speed above 20 RPM will be unacceptable since this will reduce the efficiency of the purge section.
- 11) Media cleaning shall be accomplished with any of the following methods: compressed air, low pressure steam, hot water or light detergent without degrading the latent recovery.
- 12) The wheel cassette shall be made of corrosion resistance Thermo Composite panels with aluminum frame.
- 13) In corrosive environment, protection coating added shall be epoxy coated (entire channel)

e. Fans:

- 1) Fans shall be direct drive with non-obstructive air intake and externally mounted motor. No fan belts will be acceptable for this application. Fans shall be compact, optimized and construction made of galvanized sheet steel with backward curved 7-blade airfoil geometry protected by an epoxy powder coating.
- 2) To reduce vibration, the impeller shall be balanced with hub to an admissible vibration severity of less than 3.8 mm/s in conformity with ANSI/AMCA Standard 204-05 Fan Application Category for balance and vibration: HVAC BV-3, Balance Quality Grade for rigid Rotors/Impeller: G6.3.
- 3) The fan and motor assembly shall be directly wall mounted without isolation.
- 4) Fans will require to be operated by one speed controller per fan.
- 5) The permanent magnet motors shall have high efficiencies (up to 93%+controller) with low noise, low vibration output, compact design, longer life, increased torque at start, reduced heat losses and reduced friction between components.
- 6) The motor should be able to operate between -40F and +120F ambient temperature.
- 7) Dust and humidity protection should be IP54. Motor with Adsil corrosion protective, anti- microbial coating.
- 8) An insulated shaft-rotor kit will be provided to reduce shaft voltage electrical damage to motor bearings.
- 9) Speed controller will be used to set or regulate the fan speed and airflow for these units.
- 10) The speed controller shall be capable of controlling an IPM (Internal Permanent Magnet) motor to 400Hz. An auto-tuning system shall provide the ability to drive any IPM motors.
- 11) The efficiency of the speed controller at 100% speed and load shall not be less than 95%.
- 12) There shall be a regenerative avoidance function to minimize the effect of opposite rotation of another fan within the same duct and have Out-of-Range warning system to detect any potential mechanical problems.
- 13) The speed controller shall have momentary power-loss ride-thru capability.
- 14) The speed controller shall incorporate PID and Dual PID for process controls

such as flow rate, air volume, or pressure.

- 15) The input power section shall utilize a full wave 6-pulse bridge design incorporating diode rectifiers. The diode rectifiers shall convert AC line power of fixed voltage and frequency to fixed DC voltage. This power section shall be insensitive to phase sequence of the AC line voltage.
- 16) The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall utilize insulated gate bipolar transistors (IGBT's).
- 17) The speed controller includes 3 sets of user adjustable skip frequencies and choice of 0-5Vdc, 0-10Vdc or 4-20mA speed reference for input and output.
- 18) The speed controller shall incorporate a dedicated USB port for programming.
- 19) The speed controller will have PWM control, RS-485 / BACnet RTU & carrier frequency up-to 14.5 KHz.
- 20) Control logic terminals shall be of the clamp / vibration resistant type.
- 21) The speed controller shall incorporate a radio filter capable of meeting product standard EN61800-3 for Second (2nd) Environment.
- 22) The speed controller shall have built-in PLC capable of 6k steps.

f. Filters:

1) Pre-Filters:

- a) Filters shall be factory installed where shown on the drawings.
- b) The filters shall be MERV 10.
- c) Each filter shall consist of 100% synthetic, mechanical media that does not support microbial growth.
- d) MERV 10 model High Capacity Series filters, UL 900 classified are rated as per ASHRAE test 52.2.
- e) The model High Capacity Series 400 could be operated at 500 FPM, surface area 18 FT² of media based on 24 x 24 x 2 initial static pressure at 0.24", final will be 1".
- f) Filters shall be placed in a completely sealed, galvanized holding frame with quick release latches for easy replacement.

g. Dampers – Unit Manufacturer Provided:

- 1) Dampers shall be installed where shown on the drawings.
- 2) Dampers shall be low leak type with rubber edges, opposed blades, and constructed from extruded aluminum.
- 3) Galvanized dampers will not be acceptable.
- 5) Dampers shall be installed in the compartments (as shown on the drawings) with linkage rod for actuators.
- 6) Actuators shall be 24V factory installed: two-position or modulating
- 7) All actuators shall have spring return mechanism and auxiliary switches. Dampers will be installed in the failed close positions unless otherwise noted.
- 8) Dampers, guard grills, and all accessories shall be provided by manufacturer.

h. Air Cooled Condensing Unit with Variable Speed Compressors

- 1) Provide an integral AIR COOLED CONDENSING UNIT (ACCU) section with variable speed compressors. The condensing section shall be factory piped, wired, and charged with R-454B refrigerant. The section shall be from the same manufacturer as the air handling unit. Factory mounting and piping the condensing unit, provided by a third party is not acceptable. Furthermore, the exterior cabinet of the ACCU section shall be of the same construction and paint color as the air handling unit.
- 2) Compressors shall be variable speed scroll type that can modulate from 33% to 100% capacity per compressor. Variable capacity compressors which do not modulate the speed of the scrolls are not considered equal to a variable speed scroll since they consume more energy at the same capacity output. Mechanically stepped scrolls which are unloaded via a digital signal to a solenoid valve, in a timed sequence, will not be acceptable for this application. The variable speed scrolls shall be operated via a factory supplied variable speed controller per compressor, and all tandem compressors will modulate in unison. Using a single variable speed controller on the lead circuit alone is not efficient during part load conditions, therefore will not be acceptable for this application. Each compressor and controller assembly shall be equipped with the following features: PERMANENT MAGNET MOTOR, electronic expansion valve, a crankcase heater function, anti-short cycling, built-in phase loss detector, EMC filter, oil return management system, and reverse rotation protection. All refrigeration parts, including the compressor and the speed controller, will be located in a closed and vented service compartment, separate from the condenser coil airflow.. Compressors shall be mounted on rubber isolators to limit vibration transmission.
- 3) All ACCU above 20 tons will have a minimum of two compressors.
- 4) Condenser fans shall have 7 blades with external mounted asynchronous motors that are class F insulated, IP54 and 100% variable speed. Each condenser fan bank shall be provided with a variable frequency drive which modulates via refrigerant head pressure control for superior part load performance. All the condenser fans in a fan bank shall modulate in unison for each respective circuit. Staging condenser fans are not an acceptable mode of control for head pressure control.
- 5) Protective guards shall be included on all condenser fans, and condenser coils. The coil protective guard (Permatron) shall be ideal to keep coil at maximum operating performance, protect the condenser coil from hail damage and allow for tool-free cleaning.
- 6) The condenser coils shall be micro-channel design (A1/A1) for maximum efficiency performance, consist of a single pass arrangement with integral receiver, and be pressure tested at 650 psig.
- 7) The standard ambient temperatures for cooling operation is 40F to 125F. Unit comes standard with head pressure control that can allow cooling operation down to 0F ambient air, given the ambient wind conditions permit (Max 5 mph or unit may trip on low pressure). For any lower ambient conditions down to -20F, a winter kit is required which includes two additional regulating valves, and full receiver sized for 100% refrigeration charge.
- 8) Condenser coils to be e-coated (4000 hr. salt spray resistance)

- 9) Minimum (5) five-year compressor warranties shall be provided. Refer to Section 230100 for additional requirements.

i. Air Source Heat Pump Unit with Variable Speed Compressors

- 1) Provide an integral AIR SOURCE HEAT PUMP (ASHP) section with variable speed compressors. The condensing section shall be factory piped, wired, and charged with R-454B refrigerant. The section shall be from the same manufacturer as the air handling unit. Factory mounting and piping the condensing unit, provided by a third party is not acceptable. Furthermore, the exterior cabinet of the ASHP section shall be of the same construction and paint color as the air handling unit.
- 2) Compressors shall be variable speed scroll type that can modulate from 17% to 100% capacity per compressor. Variable capacity compressors which do not modulate the speed of the scrolls are not considered equal to a variable speed scroll since they consume more energy at the same capacity output. Mechanically stepped scrolls which are unloaded via a digital signal to a solenoid valve, in a timed sequence, will not be acceptable for this application. The variable speed scrolls shall be operated via a factory supplied variable speed controller per compressor, and all tandem compressors will modulate in unison. Using a single variable speed controller on the lead circuit alone is not efficient during part load conditions, therefore will not be acceptable for this application. Each compressor and controller assembly shall be equipped with the following features: PERMANENT MAGNET MOTOR, electronic expansion valve, a crankcase heater function, anti-short cycling, built-in phase loss detector, EMC filter, oil return management system, and reverse rotation protection. All refrigeration parts up to 100 tons, including the compressor and the speed controller, will be located in a closed and vented service compartment, separate from the condenser coil airflow. Compressors will be located external to the cabinet. Compressors shall be mounted on rubber isolators to limit vibration transmission.
- 3) All ASHP above 20 tons will have a minimum of two compressors.
- 4) Condenser fans shall have 7 blades with external mounted asynchronous motors that are class F insulated, IP54 and 100% variable speed. Each condenser fan bank shall be provided with a variable frequency drive which modulates via refrigerant head pressure control for superior part load performance. All the condenser fans in a fan bank shall modulate in unison for each respective circuit. Staging condenser fans are not an acceptable mode of control for head pressure control.
- 5) Protective guards shall be included on all condenser fans, and condenser coils. The coil protective guard (Permatron) shall be ideal to keep coil at maximum operating performance, protect the condenser coil from hail damage and allow for tool-free cleaning.
- 6) The condenser coils shall be fin tube design (Al/Cu) for maximum efficiency performance.
- 7) The following components shall be included in each refrigeration circuit: Liquid line filter dryer, hi and low-pressure switch, hi and low pressure transducers, suction and liquid lines shutoff valves and suction line

accumulators. In addition, refrigeration piping must use Shrader type connections for all components, including but not limited to valves and transducers. Under no circumstances shall the units leave the factory without a complete run test and a copy of the QC report shall be provided upon request.

- 8) Minimum (5) five-year compressor warranties shall be provided. Refer to Section 230100 for additional requirements.
- 9) The standard ambient temperatures for cooling operation is 40°F to 125°F. Unit comes standard with head pressure control that can allow cooling operation down to 0°F ambient air, given the ambient wind conditions permit (Max 5 mph or unit may trip on low pressure). For any lower ambient conditions down to -20°F, a winter kit is required which includes two additional regulating valves, and full receiver sized for 100% refrigeration charge.
- 10) Condenser coils to be e-coated (4000 hr. salt spray resistance) when installed within 15 miles from a coastal environment or in known corrosive environments.
- 11) Air source heat pump option comes standard with a reversing valve. Below 40°F ambient air operation, defrost cycle will be available. Heat Pump heating lock-out will be set at 15°F (default).

j. DX Coils:

- 1) Coils shall be factory installed in the unit.
- 2) Coils shall be designed with respective circuits to match the design requirements. All coils shall have a distributor per circuit connection. Coils shall be circuited for counter-flow heat transfer to provide maximum mean effective temperature difference for maximum heat transfer rates.
- 3) Primary surface shall be round seamless (3/8" O.D.) copper tube staggered in the direction of airflow. Secondary surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.
- 4) Casing shall be constructed of continuous galvanized steel.
- 5) Coils are to be pressurized and then completely submerged in warm water containing special wetting and final cleaning agents for leak testing and tested with a minimum of 650 psi air pressure. Maximum finned height shall be 60" and shall not exceed 500 FPM face velocity.
- 6) Drain pans shall be provided on cooling coils. Cooling coils shall sit on stainless steel tubular support rails, which shall stand a minimum of (2) two inches above the highest point of the floor drain pan. Stacked coils shall be provided for larger airflows and intermediate drain pans shall be provided for each coil bank. Drain pans shall be stainless steel with 1.25" stainless steel drain connections on one side only. Pan shall be sloped in three planes.
- 7) All coils shall be rated in accordance with AHRI standard 410.

- 8) All Coils shall be coated with ElectroFin or equivalent dipped flexible cationic epoxy polymer e-coat. The electro-coat process shall ensure complete encapsulation of all conductive surfaces with uniform dry film thickness from 0.6-1.2 mils (15-25 μ m). E-coating shall meet 4B-5B rating for cross-hatch adhesion per ASTM B3359-93. COIL COATING SHALL BE FACTORY APPLIED.
- k. Hot Gas Reheat Coil (Except RTU- 2, 5, 6, 8, 9, 12, 13 &14):
- 1) Coils shall be factory installed in the unit.
 - 2) The hot gas reheat coil shall be installed at 4" from the moisture producing DX cooling coil. A plexiglass between the two items shall be required to visually inspect the DX cooling coil surface area.
 - 3) A modulating valve shall be provided to control air leaving temperature for dehumidification.
 - 4) Coils shall be designed with respective circuits to match the design requirements.
 - 5) Primary surface shall be round seamless (3/8" O.D.) copper tube staggered in the direction of airflow. Secondary surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.
 - 6) Casing shall be constructed of continuous galvanized steel.
 - 7) The complete coil shall be tested with 315 pounds air pressure under warm water and be suitable for operation at 250 psig working pressures.
 - 8) All coils shall be rated in accordance with AHRI standard 410.
 - 9) All Coils shall be coated with ElectroFin or equivalent dipped flexible cationic epoxy polymer e-coat. The electro-coat process shall ensure complete encapsulation of all conductive surfaces with uniform dry film thickness from 0.6-1.2 mils (15-25 μ m). E-coating shall meet 4B-5B rating for cross-hatch adhesion per ASTM B3359-93. COIL COATING SHALL BE FACTORY APPLIED.
- l. Hot Water Coils:
- 1) Coils shall be factory installed in the unit.
 - 2) Primary surface shall be round seamless (5/8" O.D.) copper tube with 0.018" plain wall thickness staggered in the direction of airflow. Secondary surface shall consist of a minimum 0.006" rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.
 - 3) Coils shall be circuited for counter-flow heat transfer to provide maximum

mean effective temperature difference for maximum heat transfer rates.

- 4) Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.
- 5) Casing shall be constructed of continuous stainless steel.
- 6) Coils shall be submerged in water and tested with a minimum of 315 psi air pressure. Maximum finned coil height shall be 60" and shall not exceed 500 FPM face velocity.
- 7) All coils shall be rated and certified in accordance with AHRI standard 410.
- 8) All Coils shall be coated with ElectroFin or equivalent dipped flexible cationic epoxy polymer e-coat. The electro-coat process shall ensure complete encapsulation of all conductive surfaces with uniform dry film thickness from 0.6-1.2 mils (15-25 μ m). E-coating shall meet 4B-5B rating for cross-hatch adhesion per ASTM B3359-93. COIL COATING SHALL BE FACTORY APPLIED.

m. Power and Safety Controls:

- 1) The power and control center shall be integral to the unit housing and rated equivalent to NEMA 4X.
- 2) Under no circumstances shall any wiring or parts be field installed. If units show up at the job site without wiring by the manufacturer, the contractor will have to send back units to the manufacturer at the contractors' expense to get them factory wired and re-tested.
- 3) Each panel access door shall be provided with an approved locking device.
- 4) All electrical components contained in the panel shall be UL/CSA certified and labeled. The unit shall be complete with VFDs, fuses, relays, phase protection for compressorized units, terminals for main ON/OFF and step-down transformer. All components shall be factory wired for single point power connection by the manufacturer of the unit. A non-fused safety disconnect switch with external handle shall be factory installed for ON/OFF servicing.
- 5) An electrical pipe chase for power and control feeding shall be provided next to the control panel for roof mounted units.
- 6) Any power or control wiring that is field installed shall not be accepted under any circumstances. The Short Circuit Current Rating (SCCR) is 65 kA symmetrical, as noted on schedule.
- 7) GFI and switches shall be factory installed and wired to a common junction box. A separate power connection 120V/1 will be required.
- 8) 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.
- 9) Provide unit with "BACnet general controller" to transmit additional control points from sensors provided by BAS contractor.

n. Air Temperature Controls

- 1) The unit shall be provided with factory mounted control system.
- 2) The refrigerant management controls shall be provided by the Unit Manufacturer to maintain the unit warranty.
- 3) All temperature and humidity sensors field installed by DDC contractor.

Dampers and actuators are provided, and factory installed by the Unit Manufacturer.

- 4) Refer to the Sequence of Operation and control schematic for detailed description.
- 5) Prior to Bid, the Unit Manufacturer shall coordinate the controls with controls contractor, reviewing all functions and provide a certification that all items are covered between the unit and controls.

o. Accessories – Unit Manufacturer shall provide the following:

- 1) Dirty filter switch
- 2) Door interlocking switch (for fan section)
- 3) Magnehelic gauges (Dwyer 2000 model)
- 4) Condensate overflow switch (for drain pans).
- 5) OA Air Flow Monitoring Package
 - a) The airflow measuring station shall consist of a special probe, a transducer and a display. The probe will be designed to be accurate in turbulent airflow and will be a standard design to fit all ducts. Only the number of probes will change based on the surface area. Probes can be washed down if required. The high accuracy transducer shall be mounted inside a NEMA 4 enclosure where temperature is controlled and shall also include an auto-zero function to prevent drifting. The display will indicate airflow, temperature and alarms. It will also serve as the interface to configure the system via an internal Set-up Wizard. This Set-up Wizard will include start-up, commissioning and diagnostics functions without the use of a laptop computer or other tools. All calculations, and management operations will be done within the display unit. The accuracy shall be +/- 5% of reading between 200 and 965 ft/min and +/- 10% of reading between 75 and 200 ft/min.
 - b) Fan Airflow Monitoring Station Package (Supply and Exhaust Fans)
 - c) The unit shall be delivered with factory installed airflow measuring system. The airflow measuring system, consisting of a piezometer ring and transducer, shall be installed on the fan. The package consists of an inlet port on the fan inlet cone connected with flexible tubing to the transducer.

C. Packaged Rooftop Unit (RTU-3)

1. General Description

- a. This section includes the design, controls and installation requirements for packaged rooftop unit RTU-3.

2. Quality Assurance

- a. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

- b. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- c. Unit Energy Efficiency Ratio (EER) shall be equal to or greater than that prescribed by ASHRAE 90.1, Energy Efficient Design of New buildings except Low-Rise Residential Buildings.
- d. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

3. Submittals

- a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
- b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

4. Delivery, Storage and Handling

- a. Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- c. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the installation, operation and maintenance manual.

5. Warranty

- a. Refer to Specification Section 230100 for warranty requirements.

6. Manufacturer

- a. Products shall be provided by the following manufacturers:
 - 1) Basis of design is AAON "RN" model. Units may also be provided by YORK "Sun", DAIKIN "Rebel/Rebel Applied/Maverick I/Maverick II" or TRANE "Precedent/Voyager 2/Voyager 3".

7. General Description

- a. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, condenser fans, reheat coil, hot water coils and unit controls.

- b. Unit shall be factory assembled and tested including leak testing of the DX coils, leak testing of the hot water coils, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
- c. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
- d. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
- e. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
- f. Installation, Operation and Maintenance manual shall be supplied within the unit.
- g. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
- h. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

8. 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 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929-11 for a minimum flash ignition temperature of 610°F.
- c. 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, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
- d. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous 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.
- e. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
- f. Access to filters, dampers, cooling coils, reheat coil, heaters and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
- g. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- h. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
- i. Unit shall include lifting lugs on the top of the unit.
- j. Unit base pan shall be provided with 1/2 inch thick foam insulation.

- k. Unit base shall be fabricated of 1 inch thick double wall, impact resistant, rigid polyurethane foam panels.
- l. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.

9. Electrical

- a. Unit shall be provided with standard power block for connecting power to the unit.
- b. Unit shall have a 5kAIC SCCR.
- c. Unit shall be provided with a factory installed and field wired 115V, 20 amp GFI outlet in the unit control panel.
- d. Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimize defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to ensure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined time interval has elapsed, whichever condition occurs first. During defrost cycle all compressors shall energize, reversing valves shall de-energize, and auxiliary heat shall energize.
- e. 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.

10. Supply Fans

- a. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
- b. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
- c. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
- d. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

11. Evaporator and Hot Gas Reheat Coils

- a. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
- b. Coils shall be hydrogen or helium leak tested.
- c. Coils shall be furnished with factory installed expansion valves.
- d. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum of 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per

ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6-year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual.

- e. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
- f. Lag refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

12. Heating Coils

- a. Coils shall be certified in accordance with AHRI Standard 410 and be hydrogen or helium leak tested.
- b. Coils shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
- c. Coils shall be one row, half serpentine circuitry, and 8 fins per inch.
- d. Coils shall be located in the reheat position downstream of the cooling coil.
- e. Control valves shall be field supplied and field installed.
- f. Hot water heating capacity shall be available for operation when heat pump heating is in operation and when heat pump heating is not in operation.

13. Filters

- a. Unit shall include 4-inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil. Unit shall also include 2-inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4-inch standard filters.
- b. Unit shall include a clogged filter switch.

14. Outside Air/Economizer

- a. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.
- b. Economizer shall be furnished with a California Energy Commission Certified Title 24 Fault Detection and Diagnostic package. Economizer assembly shall carry

a 5-year parts warranty from the date of original equipment shipment from the factory.

- c. Unit shall include outside airflow measuring station and airflow signal processor that communicates directly with the factory provided control systems or can also be used with customer provided controls with a 0-10 VDC output signal. BACnet shall be available. Monitoring size is dependent on the cfm.

15. Controls

- a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
- b. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
- c. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
- d. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
- e. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. The equipment manufacturer shall supply the Owner with three (3) non-expiring copies (licenses) of the required service tool software for this project valid for the life of the equipment, regardless of if the owner already has the software/license for other projects. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.
- f. 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.
- g. Provide unit with "BACnet general controller" to transmit additional control points from sensors provided by BAS contractor.

D. Packaged Rooftop Unit (RTU-18 & 19)

1. General Description

- a. This section includes the design, controls and installation requirements for packaged rooftop heat pump units RTU-18 and 19..

2. Quality Assurance

- a. Packaged rooftop air conditioning units with air-cooled condensers shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.

- b. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- c. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- d. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- e. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

3. Submittals

- a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
- b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

4. Delivery, Storage and Handling

- a. Unit shall be shipped with doors bolted shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- c. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

5. Warranty

- a. Refer to Specification Section 230100 for warranty requirements.

6. Startup and Repair

- a. Manufacturer shall provide startup and full-service warranty in accordance with Specification Section 230100.

7. Manufacturer

- a. Products shall be provided by the following manufacturers:
 - 1) Basis of design is AAON "RQ" model. Units may also be provided by YORK "Sun", DAIKIN "Rebel/Maverick I", or TRANE "Precedent".

8. General Description

- a. Packaged rooftop unit shall include compressor, evaporator coil, filters, supply fan, dampers, air-cooled condenser coils, condenser fan, modulating reheat coil, and unit controls.
- b. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
- c. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
- d. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
- e. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
- f. Installation, Operation and Maintenance manual shall be supplied within the unit.
- g. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
- h. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

9. 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 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
- c. 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, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
- d. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 210/240. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous 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.
- e. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
- f. Access to filters, dampers, cooling coil, reheat coil, heater, compressor and electrical and controls components shall be through hinged access doors with quarter turn, lockable handles. Full-length stainless-steel piano hinges shall be included on the doors. Provide door hold open devices.

- g. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- h. Units shall include double sloped 304 stainless steel drain pans.
- i. Unit shall be provided with through the base vertical discharge and return air openings. All openings through the unit shall have upturned flanges of at least 1/2 inch around the opening.
- j. Unit shall include lifting lugs on the top of the unit.
- k. Unit base pan shall be provided with 1/2-inch-thick foam insulation.

10. Electrical

- a. Unit shall be provided with standard power block for connecting power to the unit.
- b. Unit shall have a 10kAIC SCCR.
- c. Unit shall be provided with a factory installed and non-wired 115V, 12 amp GFI receptacle in the unit control panel.
- d. 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.
- e. Unit manufacturer shall provide an integral step-down transformer to power the Air Purification System. Refer to Section 2.9 in this Specification for additional information

11. Supply Fans

- a. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
- b. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
- c. Motor shall be a high efficiency electrically commutated motor.

12. Exhaust Fans

- a. Exhaust dampers shall be sized for 100% relief.
- b. Fans and motors shall be dynamically balanced.

13. Evaporator and Hot Gas Reheat Coils

- a. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
- b. Evaporator coils shall be standard capacity.
- c. Coils shall be helium hydrogen or helium leak tested.
- d. Coils shall be furnished with factory installed electronic expansion valves.
- e. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane

topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6-year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual. Coil coatings shall be applied at the factory prior to shipment of unit

14. Refrigeration System

- a. Unit shall be factory charged with R-454B refrigerant.
- b. Compressors shall be scroll type with thermal overload protection.
- c. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
- d. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
- e. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
- f. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low-pressure sides and a factory installed replaceable core liquid line filter driers.
- g. Unit shall include a two-stage compressor which shall modulate between two capacity settings, 67% and 100%.
- h. Refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
- i. The factory installed controls shall include a 3 minute off delay timer to prevent compressor short cycling and an adjustable compressor lockout.
- j. Reheat Coil shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6 year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual.

15. Air-Cooled Condenser

- a. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
- b. Coils shall be designed for use with R-454B refrigerant.
- c. Condenser coils shall be multi-pass and fabricated from aluminum microchannel tubes.

- d. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
- e. Coils shall be hydrogen or helium leak tested.
- f. Condenser fans shall be high efficiency electrically commutated motor driven with factory installed head pressure control module. Condenser airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 35°F with adjustable compressor lockout.
- g. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6 year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual.

16. Filters

- a. Unit shall include 4 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil. Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4 inch standard filters.
- b. Unit shall include a clogged filter switch.

17. Outside Air/Economizer

- a. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper. Unit shall include outside air opening bird screen, outside air hood with rain lip and barometric relief dampers.
- b. Economizer shall be furnished with a California Energy Commission Certified Title 24 Fault Detection and Diagnostic package. Economizer assembly shall carry a 5 year parts warranty from the date of original equipment shipment from the factory.

18. Controls

- a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
- b. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
- c. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.

- d. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
- e. Constant Volume Controller:
 - 1) Unit shall modulate cooling with constant airflow to meet space temperature cooling loads.
 - 2) With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.
 - 3) Unit shall modulate heating with constant airflow to meet space temperature heating loads. Heating capacity shall modulate based on space temperature.
- f. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. The equipment manufacturer shall supply the Owner with three (3) non-expiring copies (licenses) of the required service tool software for this project valid for the life of the equipment, regardless of if the owner already has the software/license for other projects. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.
- 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 be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.
- i. Provide unit with "BACnet general controller" to transmit additional control points from sensors provided by BAS contractor.

19. Roof Curbs

- a. Curbs 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. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
- b. Knockdown curb (with duct support rails) shall be factory furnished for field assembly.
- c. Solid bottom curb shall be factory assembled and fully lined with curb rated 1 inch fiberglass insulation and include a wood nailer strip. (Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications.)

20. Adapter Curbs (RTU-18 & 19)

- a. Selections based on MGM Products, Inc. or approved equal. Adapter Curb with internal SA and RA transitions are specified on the drawings.

b. Construction

- 1) Adapter Curbs must be fully welded with no field assembly required.
- 2) Height must be adjusted to ensure proper airflow.
- 3) 3.5" Out turned flange with a 3" Down turned flange for proper fit over existing curb. 1.5"x .5" in and down-turned top flange to help secure insulation.
- 4) Corners shall be fully mitered and welded.
- 5) Adapters must include a metal identification tag.
- 6) Top of adapter curbs must include insulated factory specified deck pans.
- 7) All welds coated with Zinc-rich primer: SSPC- Paint 20 Type II.

c. Materials

- 1) Minimum 16-gauge G90 galvanized steel, watertight gaskets, and complying with NRCA standards.

d. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA90B.

- 1) Materials: ASTM C1071, Type I or II.
- 2) Thickness: 1 inch or greater.

e. Insulation Application: Factory applied with adhesive and mechanical fasteners to the internal surface of the curb.

- 1) Liner adhesive: Comply with ASTM C 916, Type I.
- 2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
- 3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on surface air velocity.

2.4 UNITARY EQUIPMENT

A. Split System Air Handling Units (AHU-4, 7 and 7A)

1. General

- a. This section includes the design, controls, and installation requirements for indoor air handling units.

2. Quality Assurance

- a. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

- b. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
 - c. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL label.
- 3. Submittals
 - a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided. Run test report shall be supplied with the unit in the control compartment's literature packet, and also available electronically after the unit ships.
 - b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with detail for power and control systems and differentiate between factory installed and field installed wiring.
- 4. Delivery, Storage, and Handling
 - a. Unit shall be on a wooden pallet with skeleton crating prior to shipment to prevent damage during transport and thereafter while in storage awaiting installation.
 - b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
 - c. Unit shall be handled carefully to avoid damage to components, enclosures and finish.
 - d. Unit shall be stored in a clean, dry place protected from weather and construction traffic in accordance with Installation, Operation and Maintenance manual instructions.
- 5. Warranty
 - a. Refer to Specification Section 23 01 00 for warranty requirements.
- 6. Manufacturer
 - a. Products shall be provided by the following manufacturers:
 - 1) Basis of design is AAON "V3" model. Units may also be provided by DAIKIN "RCS", or TRANE "Odyssey".
 - b. Alternate equipment by the manufacturers listed above may be considered for approval that includes at a minimum:
 - 1) VFD driven direct drive backward curved plenum supply fans

- 2) Double wall cabinet construction
- 3) Insulation with a minimum R-value of 6.25
- 4) Hinged access doors with lockable handles
- 5) LED service lights in the control panel
- 6) Designed, engineered, and manufactured in the USA
- 7) All other provisions of this specification must be satisfactorily addressed

7. General Description

- a. Indoor air handling units shall include filters, supply fans, hot water coil, exhaust fans, energy recovery wheel and unit controls.
- b. Unit shall have a draw-through supply fan configuration and discharge air vertically.
- c. Unit shall be shipped in sections and factory assembled and tested including leak testing of the coils and run testing of the supply fans and factory wired system. Run test report shall be supplied with the unit in the control compartment's literature packet, and also available electronically after the unit ships.
- d. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
- e. Unit components shall be labeled, including electrical and controls components.
- f. Installation, Operation and Maintenance manual shall be supplied within the unit.
- g. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
- h. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

8. Construction

- a. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam injected 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.
- c. 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.
- d. 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.
- e. Access doors shall be flush mounted to cabinetry.
- f. 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.
- 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.

9. Electrical

- a. Unit shall be provided with an external control panel with separated low and high voltage control wiring. 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 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.

10. Supply Fans

- a. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
- b. Blower and motor assembly shall be dynamically balanced.
- c. Motor shall be IE5 efficiency permanent magnet totally enclosed motor. Variable frequency drive shall be factory wired and mounted in the unit.
- d. Blower and motor assembly shall utilize neoprene gasket.
- e. Access to supply fan shall be through removable bolted access panels on the top and bottom of the unit.
- f. Access to supply fan shall be through removable bolted access panels on the top and bottom of the unit or through service access door with piano hinges and lockable quarter turn handles located on the opposite access side of the unit.

11. Exhaust Fans

- a. Unit shall include direct drive, unhooded, 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 speed shall be controlled with the factory installed controller.

12. Refrigeration System

- a. Coil shall two circuits and interlaced circuitry.
- b. Air handling unit and matching condensing unit shall be capable of operation as an R-454B split system air conditioner.
- c. Modulating hot gas reheat shall be provided on the lead refrigeration circuit. Air handling unit shall be provided with hot gas reheat coil, a check valve on the liquid line, and a check valve on the hot gas reheat line. The matching condensing unit must include modulating 3-way reheat valve, liquid line receiver, electronic controller, supply air temperature sensor and a dehumidification

control signal terminal. This allows the system to have a dehumidification mode of operation and includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. Reheat line connections shall be labeled, extend beyond the unit casing and be located near the suction and liquid line connections for ease of field connection. Connections shall be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.

- d. Unit shall be configured as heat pump. Refrigeration circuit shall be equipped with a thermal expansion with an external check valve on the indoor coil.
- e. Reversing valve, outdoor coil thermal expansion valve, bi-flow filter drier, and liquid line receiver shall be factory installed in the matching condensing unit.
- f. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6-year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual. Coil coatings shall be applied at the factory prior to shipment of unit.

13. 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 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge and end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Dampers shall be controlled by a fully modulating actuator.
- c. Outdoor air temperature sensor shall be factory provided and wired to control the economizer dampers. The energy recovery wheel shall not operate during economizer mode of operation.
- d. Unit shall include 2 inch thick, pleated panel outside air filters with MERV rating of 8, upstream of the wheel.
- e. 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.
- f. Wheel frame shall slide out for service and removal from the cabinet.
- g. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
- h. 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.

- i. 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.
 - j. 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.
 - k. 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.
 - l. 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.
 - m. Energy recovery wheel, outside air dampers, economizer air dampers, and energy recovery wheel control panel access shall be through service access doors with removable pin hinges and lockable quarter turn handles.
14. Filters
- a. Unit filter access shall be through service access door with piano hinges and draw latches.
 - b. Unit shall include 4 inch thick, pleated panel filters with MERV rating of 13, upstream of the cooling coil.
15. Controls
- a. Unit shall be provided with a proof of airflow switch. When airflow is not detected, other electrical components cannot power on.

- b. Unit shall be provided with an internal control panel with separated low and high voltage control wiring.
- c. Access to external control panel shall be through an access door with removable pin hinges and lockable quarter turn handles.
- d. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
- e. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
- f. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
- g. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
- h. Constant Volume Controller
 - 1) Unit shall modulate cooling with constant airflow to meet space temperature cooling loads.
 - 2) Unit shall modulate heating with constant airflow to meet space temperature heating loads. Modulating heating capacity shall modulate based on supply air temperature.
- i. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.

16. Installation, Operation, and Maintenance

- a. Installation, Operation and Maintenance manual shall be supplied with the unit.
- b. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.
- c. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

B. Split System Condensing Unit (CU-4, 7 and 7A)

1. General

- a. This section includes the design, controls and installation requirements for air-cooled condensers / condensing units.

2. Quality Assurance

- a. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- b. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- c. Energy Efficiency Ratio (EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- d. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL label.

3. Submittals

- a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
- b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, clearances, and connection details. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

4. Delivery, Storage, and Handling

- a. Unit shall be shipped on a wooden pallet with skeleton crating prior to shipment with doors bolted shut to prevent damage during transport and thereafter while in storage awaiting installation.
- b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- c. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

5. Warranty

- a. Manufacturer shall provide startup and full-service warranty in accordance with Specification Section 230100.

6. Manufacturer

- a. Products shall be provided by the following manufacturers:
 - 1) Basis of design is AAON "CF" model. Units may also be provided by DAIKIN or TRANE.
- b. Alternate equipment by the manufacturers listed above may be considered for approval that includes at a minimum:
 - 1) R-454B refrigerant
 - 2) Hinged access doors with lockable handles
 - 3) 2,500 hour salt spray exterior corrosion protection

- 4) Designed, engineered, and manufactured in the USA
- 5) All other provisions of the specifications must be satisfactorily addressed.

7. General Description

- a. Air-Source heat pump condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, accumulator, receiver, reversing valve, filter driers with check valves, and thermal expansion valves.
- b. Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the control compartment.
- c. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
- d. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
- e. Installation, Operation and Maintenance manual shall be supplied within the unit.
- f. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
- g. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

8. Construction

- a. Unit shall be completely factory assembled, piped, and wired and shipped in one section.
- b. All cabinet walls, access doors, and roof shall be fabricated of G90 galvanized steel panels.
- c. Unit shall be specifically designed for outdoor application.
- d. Access to compressors and control components shall be through hinged access doors with quarter turn, lockable handles.
- e. Access to condenser coils and fans is through removable access panels.
- f. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- g. Unit shall include lifting lugs.
- h. Unit shall include forklift slots.
- i. Unit shall be provided with hail guards to protect condenser coils.

9. Electrical

- a. Unit shall be provided with standard power block for connecting power to the unit.
- b. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.
- c. Unit shall have a 5kAIC SCCR.

- d. Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimize defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to insure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined time interval has elapsed, whichever condition occurs first. During defrost cycle all compressors shall energize, reversing valves shall energize, and auxiliary heat shall energize.
- e. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
- 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.

10. Refrigeration System

- a. Each compressor shall be furnished with a crankcase heater.
- b. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.
- c. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators and mounted on an elevated compressor deck, to reduce any transmission of noise from the compressors into the building area.
- d. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided and installed. Field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line and insulated hot gas bypass line, insulated hot gas reheat line and insulated suction line.
- e. Unit shall include a factory holding charge of R-454B refrigerant and oil. Adjusting the charge of the system will be required during installation.
- f. Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall be equipped with a bi-flow liquid line filter drier, reversing valve, suction line accumulator, liquid line receiver, and a bypass loop with check valve around a thermal expansion valve. Reversing valve shall de-energize during the heat pump heating mode of operation. The matching indoor air handler must include a bypass loop with check valve around the thermal expansion valve.
- g. The factory installed controls shall include a 3 minute off delay timer to prevent compressor short cycling. The controls shall also include an adjustable, 20 second delay timer for each additional capacity stage to prevent multiple capacity stages from starting simultaneously and adjustable compressor lock out.
- h. Units shall be provided with a suction pressure transducer on each refrigeration circuit.

- i. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6-year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual. Coil coatings shall be applied at the factory prior to shipment of unit.

11. Fans

- a. Condensing unit shall be provided with an electrically commutated motor (ECM) condenser fan, condenser head pressure controller, and discharge pressure transducers for modulating head pressure control to allow cooling operation down to 35°F. Fan motor shall be weather protected, single phase, direct drive, and totally enclosed air over (TEAO) with electronic protection.

12. Installation, Operating, and Maintenance

- a. Installation, Operation and Maintenance manual shall be supplied with the unit.
- b. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.
- c. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

C. Computer Room Air Conditioning Unit (SS-1/OU-4)

1. General

- a. This section includes the design, controls, and installation requirements for a split configuration with compact depth indoor vertical floor console mounted dx evaporator precision air conditioner with outdoor dx air cooled propeller fan remote condenser. The system is designed to control space temperature and humidity.

2. Quality Assurance

- a. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- b. Unit shall be factory run tested prior to shipment.

3. Submittals

- a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics, and connection

requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided. Run test report shall be supplied with the unit in the control compartment's literature packet, and also available electronically after the unit ships.

- b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with detail for power and control systems and differentiate between factory installed and field installed wiring.

4. Delivery, Storage, and Handling

- a. Unit shall be on a wooden pallet with skeleton crating prior to shipment to prevent damage during transport and thereafter while in storage awaiting installation.
- b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- c. Unit shall be handled carefully to avoid damage to components, enclosures and finish.
- d. Unit shall be stored in a clean, dry place protected from weather and construction traffic in accordance with Installation, Operation and Maintenance manual instructions.

5. Warranty

- a. Refer to Specification Section 23 01 00 for warranty requirements.

6. Manufacturer

- a. Products shall be provided by the following manufacturers:
 - 1) Basis of design is ABOVE AIR TECHNOLOGIES indoor model "FCE-012S", outdoor model "XP1-012S".

7. General Description

- a. Indoor air handling units shall include filters, supply fans, hot water coil, exhaust fans, energy recovery wheel and unit controls.

8. Construction

- a. All cabinet walls and access panels shall be powder-coat painted heavy gauge galvanized steel for décor matching and corrosion resistance. Cabinet access panels shall rest in recessed pockets designed for minimum air leakage. The cabinet and access panels shall be lined with 2 lb/ft² high density sound and thermal insulation and sealed with self-extinguishing gasketing conforming to NFPA 90A and 90B.
- b. Unit shall be serviceable through front access panels with quick-release quarter-turn fasteners.

9. Electrical

- a. System shall conform to National Electric Code (NEC) requirements according to UL 1995.
- 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.

10. Evaporator Blower

- a. Unit shall include direct drive centrifugal type, double width double inlet.
- b. Blower and motor assembly shall be dynamically balanced.

11. Filters

- a. Unit filter access shall be through a side service access panel without shutting down the system.
- b. Unit shall include 2 inch thick, pleated panel filters with MERV rating of 8, upstream of the cooling coil.

12. Controls

- a. Unit shall be provided with an MC-2000 advanced microprocessor based temperature and humidity controller with alarms.

D. Ductless Split System Air Handling Unit (IU-1, 2 & 3)

1. General

- a. Basis-of-design manufacturer is LG. Acceptable alternate manufacturers include DAIKIN and MITSUBISHI.
- b. Unit shall be factory-assembled, wired, piped, and run tested.
- c. Unit shall be designed to be installed in indoor application.

2. Casing

- a. Unit shall be designed to mount on a vertical surface and come complete with an installation mounting guide and a separate hanging bracket. The interior unit case shall be manufactured with coated metal. Cold surfaces shall be covered with a coated polystyrene insulating material.
- b. The exterior unit case shall be manufactured using ABS polymeric resin and have a pearl white finish.

3. Fan Assembly and Control

- a. The unit shall have a single, direct-drive, crossflow tangential Sirocco fan made of high strength ABS BSN-7530 polymeric resin.

- b. The fan motor shall consist of a brushless digitally controlled (BLDC) design with permanently lubricated and sealed ball bearings.
 - c. The fan motor shall include thermal, overcurrent, and low RPM protection.
 - d. The fan motor assembly shall be mounted on vibration attenuating rubber grommets.
 - e. The fan impeller shall be statically and dynamically balanced.
 - f. The fan speed shall be controlled using a microprocessor-based direct digital control algorithm that provides a high fan speed in cooling thermal ON and low fan speed in cooling thermal OFF, high fan speed in heating thermal ON and fan off in heating thermal OFF.
 - g. The fan speeds shall be field adjustable between low, medium, and high speeds. The fan speed algorithm shall provide a field-selectable fixed-speed or auto-speed setting that changes the fan speed to simulate natural airflow.
4. Air Filter
- a. Return air shall be filtered with a removable, washable filter with anti-fungal treatment. Filter access shall be from the front of the unit without the use of tools.
5. Airflow Guide Vanes
- (5-15 MBh)
- a. The indoor unit shall be provided with a motorized oscillating guide vane that automatically changes the direction of up-and-down airflow.
 - b. The indoor unit shall include factory installed, manually adjustable guide vanes that control the side-to-side direction of supplied airflow.
- (18-36 MBh)
- a. The indoor unit shall be provided with a motorized sweeping guide vane that automatically changes the direction of airflow from side-to-side and up-and down.
6. Microprocessor Control
- a. The unit shall be provided with an integrated microprocessor controller capable of performing functions necessary to operate the system without the use of a wall-mounted controller. A temperature thermistor shall be factory-mounted in the return air stream. All unit operation parameters, excluding the operating schedule, shall be stored in non-volatile memory resident on the unit microprocessor. Operating schedules shall be stored in the wall-mounted, local, or central controller. Mechanical contractor shall coordinate with BAS contractor and Owner to determine the desired location for operating schedules.
 - b. The field-supplied communication cable between the indoor unit and outdoor unit shall be a minimum of 18 AWG, 2 conductor, stranded, and shielded cable (RS-485), terminated via screw terminals on the control boards. The microprocessor control shall provide the following functions: auto addressing, self-diagnostics, auto restart following power restoration, test run, and shall operate the indoor unit using one of four operation modes:

- 1) Heating
 - 2) Cooling
 - 3) Dry
 - 4) Fan only
- c. Heated or cooled air delivery shall be dependent on outdoor unit operating mode.
- d. In heating mode, the microprocessor control shall activate indoor unit operation when the indoor room temperature falls below set-point temperature. At which point, a signal shall be sent to the outdoor unit to begin the heating cycle. The indoor unit fan operation shall be delayed until coil pipe temperature reaches 76°F. Significant airflow shall be generated when pipe temperature reaches 80°F. A field-selectable option shall maintain fan operation for 30 minutes following cooling cycle operations. The unit shall be equipped with an infrared receiver designed to communicate with a wireless remote controller. In lieu of wireless remote or factory return air thermistor, screw terminals on the microprocessor circuit board shall accommodate various models of wall-mounted local controllers. The unit microprocessor shall be capable of accepting space temperature readings concurrently or individual from either a wall-mounted wired controller or a factory-mounted return air thermistor.
- e. A single indoor unit shall have the capability of being controlled by up to two local wired controller. The microprocessor shall control space temperature using the value provided by the temperature sensor sensing a space temperature that is farthest away from the temperature set-point. The microprocessor control shall provide a cooling or heating mode test cycle that operates the unit for 18 minutes without regard to the space temperature. If the system is provided with an optional wall-mounted local or central controller, displayed diagnostic codes shall be specific, alpha-numeric, and provide the service technician with a reason for the code displayed.
- f. The unit shall include the following controls features:
- 1) Auto operation
 - 2) External on/off control
 - 3) Dual thermistor control
 - 4) Dual set-point control
 - 5) Filter life display
 - 6) Group control
 - 7) Forced operation
 - 8) Hot start
 - 9) Self diagnostics
 - 10) Timer (on/off)
 - 11) Weekly schedule
 - 12) Auto direction/swing (up/down)
 - 13) Fan speed control
 - 14) Jet cool (fast cooling)
 - 15) Auto Fan
 - 16) Leak detection

7. Condensate

- a. The unit shall be designed for gravity draining of condensate. The manufacturer shall provide a factory insulated flexible drain hose.
 - b. The condensate drain pan shall be constructed of expandable polystyrene resin (EPS).
 - 8. Coil
 - a. The indoor unit coil shall be constructed with grooved design copper tubes with slit coil fins, two (2) rows, eighteen (18) fins per inch.
- E. Ductless Split System Condensing Unit (OU-1, 2 & 3)
- 1. General
 - a. The heat pump system shall consist of an outdoor unit, at least one indoor unit, integrated system controls, and interconnecting field-provided refrigerant pipe containing various fittings including Y-branch kits and Header kits (as necessary). Components shall be manufactured in a facility that meets or exceeds International Organization for Standardization (ISO) 9001 and 14001. The units shall be listed by Intertek (ETL) and bear the ETL listed mark.
 - b. Basis-of-design manufacturer is LG. Acceptable alternate manufacturers include DAIKIN and MITSUBISHI.
 - 2. Casing
 - a. The outdoor unit case shall be constructed from 22-gauge coated metal. Exterior panels shall be cleaned and finished with a weather-resistant baked enamel finish.
 - b. An easily removable front corner panel shall be provided to allow access to major components and control devices.
 - c. Outdoor unit fan(s) shall be covered with guards made of heavy gauge, heavy duty polymeric resin. The outdoor unit shall be protected with a heavy gauge steel wire guard finished with baked enamel.
 - d. Paint color shall be "warm gray."
 - 3. Refrigeration System
 - a. The refrigeration system shall consist of a single refrigeration circuit and shall use refrigerant R-32.
 - b. The outdoor unit shall be provided with factory installed components, including a refrigerant strainer, oil separator, accumulator, hot gas bypass valve, liquid injection valve, four-way reversing valve, electronic controlled expansion valve (EEV), high and low side charging ports, service valves, and interconnecting piping. An integral subcooler assembly shall also be included, consisting of a double spiral tube type heat exchanger and EEV providing refrigerant subcooling modulation up to 23°F.
 - 4. Refrigeration Oil Control

- a. The refrigeration oil level in the compressor shall be maintained using a two-stage oil control system. The compressor discharge port shall be equipped with an oil filtering device designed to restrict oil loss from the compressor.
- b. The high-pressure discharge vapor shall leave the compressor and immediately enter a centrifugal oil separator that has no moving parts designed to extract oil from the refrigerant gas stream. A gravity drain shall return captured oil back to the compressor sump.
- c. The outdoor unit microprocessor shall be programmed to flush the refrigerant piping system for a minimum period of three (3) minutes after eight (8) hours of compressor operation.

5. Single Inverter/Compressor

- a. The outdoor unit shall be equipped with one hermetic, digitally-controlled inverter starting compressor. The compressor shall be specifically designed for the refrigerant provided and manufactured by the unit manufacturer.
- b. The frequency inverter shall be designed by the unit manufacturer and shall be capable of providing a modulation range from 20 Hz to 75 Hz (cooling and heating) modulating in increments of 1.0 Hz.
- c. The compressor motor shall be suction gas-cooled and have an acceptable voltage range of $\pm 10\%$ of nameplate voltage.
- d. External suction and discharge temperature and pressure sensors shall be provided to protect the compressor from damage caused by over/under temperature or over/under pressure conditions.
- e. The compressor shall be provided with a positive displacement oil pump providing sufficient oil film on all bearing surfaces across the entire inverter modulation range.
- f. The compressor shall be factory-charged with Polyvinyl ether (PVE) refrigeration oil having no hygroscopic properties. Compressor bearings shall be Teflon coated.
- g. The compressor shall be wrapped with a heat resistant, sound attenuating blanket and mounted on rubber isolation grommets.

6. Outdoor Unit Coil

- a. Outdoor unit coils shall be a minimum of two rows 14 fins per inch, and manufactured using copper tubes with mechanically bonded aluminum louvered fins.
- b. Fin surfaces shall be coated with Gold-Fin corrosion resistant hydrophilic silica gel coating.
- c. Coils shall be pressure tested at a minimum of 551 psig.

7. Fans and Motors

- a. Units shall be furnished with one axial flow fan providing horizontal airflow from the rear and discharging from the front of the unit. Fan blades shall be 20-1/2 inch diameter, balanced, and made of durable acrylonitrile butadiene styrene (ABS) polymeric resin.
- b. Motors shall be designed to operate between 0 and 850 RPM in cooling and heating. Fans shall be driven by digitally controlled inverters that vary the fan

speed. Motors shall be brushless, digitally controlled (BLDC) and have permanently lubricated and sealed ball bearings.

- c. All outdoor units shall be controlled by an inverter drive mounted near the main microprocessor.
- d. The outdoor unit fan speed shall be controlled using an algorithm that provides three pre-programmed fan speeds. DIP Switch adjustable settings shall limit nighttime (off peak) fan speed to reduce fan generated noise by up to 10 dB(A).

8. Outdoor Unit Controls

- a. Outdoor units are factory wired with necessary electrical control components, printed circuit boards, thermistors, sensors, terminal blocks, and lugs for power wiring. The control wiring circuit shall be low voltage and include a control power transformer, fuses, and interconnecting wiring harness with plug connectors. Microprocessor based algorithms provide component protection, soft-start capability, refrigeration system pressure and temperature control, defrost, and ambient control. The unit shall be designed to provide continuous compressor operation from -9.9°F to 122°F in cooling mode.
- b. When the system is started, the connected indoor units shall be automatically assigned an electronic address by the outdoor unit's microprocessor. Additionally, each indoor unit shall be capable of accepting a manual assignment of a secondary electronic address that, if used, shall provide unit tag identification when integrating with additional control devices.
- c. While operating in Heating mode, the outdoor unit shall have a demand based defrost control algorithm and a refrigeration system pump down cycle designed to store refrigerant in the outdoor unit up to 4.4 lbs for the 2 ton unit. In heating mode, a cooperative control algorithm shall automatically balance, in real-time, the distribution of refrigerant to the indoor units when the system's refrigerant mass flow is insufficient to satisfy the demand of all indoor units when the system is called on to operate outside the system design parameters.
- d. In 10-second intervals, the outdoor unit microprocessor shall record the last three minutes of system run-time data in non-volatile memory. Upon unit malfunction, or a power outage that results in a system shutdown, the stored system operational data shall be retrieved and analyzed to assist in diagnosing a system malfunction.
- e. The outdoor unit microprocessor shall be provided with a three-digit, LED display that shall communicate active system information and/or malfunction codes. The microprocessor shall have an algorithm that actively verifies the operational condition of system sensors and thermistors. A refrigerant auto-trim-charge algorithm shall assist the installer with properly charging the system.
- f. A power conditioning circuit shall be provided to protect the unit's inverter compressor and outdoor unit fan motors from phase failure, phase reversal, sense an under-voltage or over-voltage condition, and to prevent transmission of power irregularities to the supply power source. A snow throw algorithm shall be provided and designed to reduce snow buildup on the discharge side louvers at regular intervals.

2.5 TERMINAL EQUIPMENT (NOT USED)

2.6 HVAC PIPING AND SPECIALTIES

A. PIPING

1. Water, refrigerant, and HVAC drain piping shall be provided as specified below. Where options of different materials are given for the same service, contractor shall select materials and use them uniformly throughout the system. Contractor shall submit experience with all of the materials and joining methods specified.
2. Hot water piping:
 - a. Above ground
 - 1) Type L copper (2 inch and under)
 - 2) Schedule 40 threaded black steel (2 inch and under)
 - 3) Schedule 40 welded black steel (2-1/2 inch and over)
3. Condensate drain piping:
 - a. Above ground (within building and plenum rated ceiling)
 - 1) Type L copper
 - b. On rooftop and exterior to building
 - 1) Schedule 40 PVC
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)
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. All concealed condensate drain piping shall be labeled at its termination point to indicate whether the drain piping is connected to a primary or secondary (auxiliary) mechanical unit drain.

B. Pressurized Expansion Tanks:

1. Tanks shall be ASME Code construction for 125 psi service, of sizes indicated. Tanks shall be pre-charged bladder type. Tank shall be BELL & GOSSETT Series "B," ARMSTRONG "L Series," or TACO "CA."
 - 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 240°F.
 - 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.

C. Pressure Relief and Reducing Valves

1. Provide relief and reducing valves with fast fill feature. Construction shall be cast iron with brass seats and brass strainer. BELL & GOSSETT, or approved equal.

D. Air Eliminator and Dirt Separator:

1. Provide a full flow coalescing type combination air eliminator and dirt separator on the hot water system. Unit shall be SPIROTHERM "VDN," BELL & GOSSETT "SRS," or TACO "Series 4900."
2. Full flow coalescing type combination air eliminator and dirt separator shall be fabricated steel, rated for 150 psig working pressure, stamped, and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels, and include two equal chambers above and below the inlet / outlet nozzles.

3. Selection shall be based upon system flow with pipe size as a minimum. In no case shall entering velocity exceed 10 feet per second.
4. Unit shall include internal structured elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. The elements shall be fabricated by the manufacturer and consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.
5. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
6. Units shall include a side tap valve to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
7. Unit shall be manufactured with a removable lower head for internal inspection.

E. Air Vents:

1. Provide automatic air vents where indicated and at all high points in the hydronic system. Vents shall be BELL & GOSSETT "107A," CALEFFI "MAXCAL," or WATTS "DUOVENT."

F. Thermometers

1. Thermometers shall be provided as indicated. Thermometers shall be WEKSLER "5AAE," DWYER "BT," or WEISS "5VBM."
2. Thermometers in pipelines shall be separable socket 5" dial bi-metal insertion type, with scale suitable for temperature range of medium being measured. Thermometers shall be located to facilitate reading from floor. Angle-type shall be used where necessary to facilitate reading. Install in thermal well in flow of fluid.
3. Thermometer range shall be 0-150°F for chilled water and condenser water, and 30-240°F for hot water.

G. Pressure Gauges

1. Pressure gauges shall be provided on suction and discharge line of each pump and where indicated. WEKSLER "HA-14-4," KOBOLD "MAN-R," or WIKA "232.50."
2. Gauges 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.
3. Pressure gauges shall be located to facilitate reading from floor.

H. 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. IMI "SANA," PETERSON "Pete's Plug," NEXUS "PT," or equal.

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2. One master test kit shall be provided to the Owner. Kit shall contain one 2-1/2" pressure gauge of suitable range, one gauge adapter 1/8" o.d. probe, and one 5" stem pocket testing thermometer 0° to 220°F.

I. Valves:

1. Valves 2" size and under shall be bronze with soldered ends, rough bodies, and finish trim. Valves 2-1/2" size and over shall be iron-body, bronze-mounted with flanged ends, except where specifically indicated. Valves on cold piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Catalog numbers indicated below are NIBCO. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.

Size	Pipe Material	Check	Ball/Butterfly
2" and under	Copper	S-413-W	S-585-70-66NS
2-1/2" and over	Copper	F918-B	LC-3000
2-1/2" and over	Steel	F918-B	LC-3000

2. Check valves in pump discharge lines shall be NIBCO F-910-B-LF. Valve shall be flanged, cast iron, globe style, and constructed with lead-free bronze seat per ASTM B584 with Buna-N O-ring. Valve shall utilize stainless steel spring with aluminum bronze bushing. Acceptable alternate valves include MILWAUKEE "1800" or METRAFLEX "CV0900-125-12-DINC."
3. Balancing valves 2" and smaller shall be NIBCO S-585-70-66NS. Balancing valves 2-1/2" and larger shall be butterfly valves as specified below. Valves shall be complete with memory stops. Valves on cold piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Acceptable alternate valves include MILWAUKEE "BA-150S-MS," or APOLLO "70-200-27."
4. Butterfly valves used for balancing purposes shall be NIBCO "LD-3000." Valve shall be ductile iron, lug type and suitable for dead-end service, 250 psig, bubble-tight shutoff, and 250°F service. Disc shall be aluminum bronze with 416 stainless-steel extended shaft and copper or brass bushings. Seal shall be EPDM. Provide lever actuators with ten positions with memory stops. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Valves 6" and above shall be provided with gear operators. Acceptable alternate valves include MILWAUKEE "ML333ES" or APOLLO "LD 141."
5. Pressure Relief Valves:
 - a. Provide as shown on plans a diaphragm operated safety relief valve, ASME labeled for relieving pressure of 30 psig with a rating of 790,000 BTU/hr.
 - b. The fluid shall not discharge into the spring chamber. The valve shall have a low blow-down differential.
 - c. The valve seat and all moving parts exposed to the fluid shall be non-ferrous material.
 - d. Provide BELL & GOSSETT "790-30", APOLLO "10-102," or ZURN "P1000AXL-30C."

J. Chemical Shot Filter Feeder:

1. Provide one feeder for each the hot water systems. Feeder shall be NEPTUNE “DBF,” ADVANTAGE CONTROLS “BF,” WESSELS “CPFTA,” or equal.
2. Tanks shall be ASME Code construction for 125 psi service, 5-gallon chemical shot feeder. Feeder shall include funnel, isolation valves, and adjustable base legs.

K. Y-Strainers:

1. System strainers in mechanical rooms:
 - a. “Y” Pattern pipeline strainers shall be installed where shown on plans or required by equipment manufacturers.
 - b. Y Strainer shall be of the low pressure drop design with the following C_v values:
 - (1) 4” Pipe: 460
 - (2) 6” Pipe: 952
 - (3) 8” Pipe: 1580
 - c. Y Strainer shall be METRAFLEX “LPD,” or equal.
 - d. Strainer body shall be ASTM A126-B Cast Iron.
 - e. Screens shall be Type 304 Stainless steel.
 - f. Screen perforations shall be 0.125.”
 - g. Strainer shall have a screen pitch of 22.5°.
 - h. Screens shall be removable via an access cover sealed with O-ring.
 - i. Strainer shall be manufactured with .25” pressure differential ports, with one placed on each side of the screen.
 - j. Strainer shall be equipped with a dry well port. Port shall be 1” for sizes 4” – 12”.
 - k. Strainer connection shall be 125 lb. class flange.
 - l. Y Strainer shall be installed in accordance with manufacturer’s recommendations and contact requirements.
 - m. Provide valved blow-off outlet with hose connection and cap on each strainer. Blow-off connections shall be at bottom of strainer and shall be of size equal to 1/2 the pipe up to a maximum of 2”.
2. Strainer for unitary coils
 - a. Strainers shall be self-cleaning “Y” type, of same size as pipe in which it is installed.
 - b. Provide valved blow-off outlet with hose connection and cap on each strainer. Blow-off connections shall be at bottom of strainer and shall be of size equal to 1/2 the pipe up to a maximum of 2”.
 - c. Screen perforations shall be suitable for intended service. Provide 50-micron mesh screen minimum for flushing of system.

L. Base Mounted End Suction Circulating Pumps (P-1 & 2):

1. Provide pumps with performance characteristics as shown on plans. Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow removal and service of the entire rotating assembly without disturbing the pump piping, electrical motor connections or pump to motor alignment. Basis of design shall be BELL &

GOSSETT “E-1510”. Acceptable alternates include ARMSTRONG “4030” and TACO “FI”.

2. Components

- a. Pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet. The impeller shall be a cast stainless steel enclosed type, balanced to ANSI/HI 9.6.4-2016 balance grade G6.3 and secured to the shaft by a locking cap screw or nut.
- b. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F. A replaceable stainless steel shaft sleeve shall completely cover the wetted area under the seal.
- c. Pump shall be rated for minimum of 175 psi working pressure. Volute shall have gauge taps at the suction and discharge nozzles and vent and drain taps at the top and bottom.
- d. The pump vibration limits shall conform to Hydraulic Institute ANSI/HI 9.6.4-2016 for recommend acceptable unfiltered field vibration limits (as measured per ANSI/HI 9.6.4-2016 Figure 9.6.4.2.3.1) for pumps with rolling contact bearings.
- e. Baseplate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully open. The combined pump and motor baseplate shall be sufficiently stiff as to limit the susceptibility of vibration. The minimum baseplate stiffness shall conform to ANSI/HI 1.3.8.2.1-2019 for grouted Horizontal Baseplate Design standards.
- f. A flexible type, center drop-out design coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupling sleeve. The coupling shall be shielded by a dual rated ANSI B15.1 & OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling.
- g. Motor shall meet NEMA and EISA 2007 (where applicable) specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned and shall be realigned by the contractor per factory recommendations after installation. Motor shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
- h. The pump shall conform to ANSI/HI 9.6.3.1-2012 standards for Preferred Operating Region (POR) unless otherwise approved by the engineer. Each pump shall be factory hydrostatically tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high-grade paint prior to shipment.
- i. The pump shall be manufactured, assembled, and tested in an ISO 9001 approved facility.

3. Provide suction diffusers matched to pump and system piping for end suction pumps.
4. Provide Aegis Shaft Grounding Rings on all pump shafts to extend the life of the bearings.
5. Pumps shall be grouted in accordance with manufacturer’s recommendations.

M. Inline Circulating Pumps

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1. Provide pumps with performance characteristics as shown on plans. Basis of design shall be BELL & GOSSETT "E-80". Acceptable alternates include ARMSTRONG "4380" and TACO "KV."
2. Components:
 - a. The pumps shall be close-coupled, inline for vertical or horizontal installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
 - b. The pumps shall have a solid alloy steel shaft that is integral to the motor. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
 - c. The motor bearings shall support the shaft via heavy-duty grease lubricated ball bearings.
 - d. Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have a stainless-steel housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
 - e. Pump shaft shall connect to a stainless-steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.-2016. The allowable residual imbalance conforms to ANSI grade G6.3, keyed to the shaft and secured by a stainless-steel locking cap screw or nut.
 - f. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
 - g. Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.
 - h. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall have heavy-duty grease lubricated ball bearings to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
 - i. Pumps shall conform to ANSI/HI 9.6.3.1-2012 standard for Preferred Operating Region (POR) unless otherwise approved by the Engineer.
 - j. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
 - k. Pump manufacturer shall be ISO-9001 certified.
 - l. Each pump shall be factory tested and name-plated before shipment. Pump shall be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

N. Suction Diffusers

1. Suction diffusers shall be provided at the suction side of pumps as indicated on the drawings. Suction diffusers shall be BELL & GOSSETT "Suction Diffuser Plus," ARMSTRONG "SG," or TACO "SD."
2. Units shall consist of angle type body, flanged system connection, integrated flow cone, stainless steel straightening vane, and combination diffuser/strainer/orifice cylinder with 3/16" diameter openings for pump protection. The unit shall include a disposable fine mesh strainer which shall be removed after system startup.
3. Unit shall have pressure/temperature ports at the suction and discharge to allow for measurement of differential pressure across the unit.
4. Orifice cylinder shall be designed to withstand pressure differential equal to the pump shut-off head and have a free area equal to five times the 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 adjustable support foot to carry the weight of suction piping.
5. Unit shall be rated for 175 psi maximum working pressure and 250°F maximum working temperature.
6. 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.

O. Flexible Pipe Connectors (Pumps)

1. Provide spool-type expansion joint, standard single-arch type, on suction and discharge piping of base-mounted pumps, and where indicated. KEFLEX "Series S," METRAFLEX "100 HT," LINK-FLEX "Style 75," or 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.

P. Automatic Balancing Valves

1. Provide automatic measuring and balancing valves where indicated for pipe sizes 1/2" to 12". Valves shall be NUTECH "AB," IMI "AC," or CALEFFI "Series 121" for valves 1/2" through 2". Valves 2-1/2" and larger shall be NUTECH "AW," IMI "WS," or HCI "AT."
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 like 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 shall 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.
12. For 2-1/2" and larger flanged connections: Ductile-iron body suitable for mounting wafer style between standard 150# or 300# flanges. The long flange bolts and nuts shall be provided with each automatic flow control valve.
13. All valves shall be factory leak tested at 100 psi air underwater.
14. Ratings: 1/2" through 2" pipe size: 600 psig at 250°F
2-1/2" through 12" pipe size: 600 psig at 250°F
15. Where indicated on the plans, the differential pressure across the automatic flow control valve shall be measured for flow verification and to determine the amount of system over-heading or under-pumping. Where over-heading exists the ball valve shall be throttled to bring the flow cartridge back within the control range. The valve memory stop shall be set so the valve can be used for isolation and reopened to the balanced position.
16. The flow shall be verified by measuring the differential pressure across the coil served or the wide-open temperature control valve and calculating the flow using the coil or valve C_v .
17. A differential pressure test kit shall be supplied to verify flow and measure over-heading. The kit shall consist of a 4-1/2" diaphragm gauge equipped with 10-foot hoses and P/T adapters, all housed in a vinyl case. Calibration shall be 0-35 PSID for 2-32 PSI spring range or 0-65 PSID for 5-60 PSI range.
18. Install automatic flow control valves on the return lines of coils as indicated on the plans. Balancing valve on supply side is not acceptable. Submit proposed piping arrangement for approval by the Engineer.
19. The standard ports and handles shall clear 1" thick insulation. Handle and port extensions are required for over 1" thick insulation.
20. Install, on the supply side of coils, a Y-strainer with a brass blow-down valve with 3/4" hose end connection with cap and chain.

Q. Manual Venturi Flow Measuring and Balancing Valves:

1. Provide manual venturi flow measuring and balancing valves where indicated. For pipe sizes 1/2" to 2", valves shall be NUTECH "MB," IMI "UA," or BELL & GOSSETT "MV." For pipe sizes 2-1/2" and larger, valves shall be NUTECH "MF," IMI "AF," or BELL & GOSSETT "MVF."
2. Balancing valves 1/2" through 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. Sizes 8" and larger shall

be fabricated carbon-steel with carbon steel insert. 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 to unlock the valve or losing the balancing position valve sizes 2" through 6". Gear operator shall be supplied with valve sizes 8" and larger.
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.
8. Total pressure drop shall not exceed one foot.
9. Flow rate increments shall be suitable for the indicated flow rate.

2.7 AIR DISTRIBUTION

A. Ductwork

1. Provide all ducts, plenums, connections, dampers, and related items required to form a complete system as indicated on drawings and specified herein.
2. All ductwork shall be constructed of sheet metal unless otherwise indicated.
3. Sheet-metal ducts shall be fabricated from G90 galvanized-steel sheets, 304 stainless steel, or 3003 aluminum, and shall be of gauges called for and as detailed in 2020 SMACNA Manual, HVAC Duct Construction Standards (Metal and Flexible). All ductwork pressure class construction shall be as indicated on the drawings and shall be single wall rectangular or single wall round. Rectangular ductwork shall be single-wall construction unless otherwise indicated except ductwork exterior to the building shall be double wall with 3" insulation encapsulated between inner and outer sheet metal shells.
4. Duct sealing requirements shall be Class A for all ductwork.
5. Round duct and fittings shall be manufactured by a company for whom the manufacture of spiral duct and welded fittings has been a principal business for at least 15 years. Contractor fabricated round spiral duct and fittings shall not be acceptable.
6. All companies being considered as potential suppliers of duct and fitting components shall submit drawings and dimension data for approval. These submittals will serve as a basis for acceptance or rejection of product.
 - a. All fittings furnished for use on a project must be identical to the approved submittal data.
 - b. Any fittings rejected by the project engineer shall be replaced with fittings equal to the original approved submittals. All expenses incurred in the replacement of fittings that do not conform to these requirements shall be the responsibility of the installing contractor.

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7. All medium pressure supply duct shall be of round spiral lockseam or rectangular 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 2020 SMACNA HVAC DCS, except no 28 gauge material is allowed:

Diameter (inches)	Standard Spiral Gauge		Single-Rib Spiral Gauge
	0-2" w.g.	2-10" w.g.	0-10" w.g.
3-8	28	26	--
9-14	28	26	28
15-26	26	24	28
27-36	24	22	28
37-42	22	20	28

8. Duct shall be provided in continuous, un-joined lengths wherever possible. Except when interrupted by fittings, round spiral duct sections shall not be less than 12 feet long. Round spiral pipe and fittings greater than 24" diameter, will have flanged connections. Flanges for dual wall duct must also hold the inner liner of dual wall duct concentric without the use of additional couplings or spacers.
9. Double-wall round and rectangular ductwork shall be used where indicated. Double wall round shall be of spiral lockseam construction. Double wall round and rectangular shall have 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. Ductwork above the roof shall have a 3" thick insulation layer.
10. Unless otherwise specified, all double-wall duct and fittings shall be a minimum G-90 galvanized sheet metal. All spiral pipe used for inner and outer shells shall 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

11. Fittings shall be of the following minimum gauges:

Nominal Duct Size	Inner/Outer Shell (Gauge)	Inner Shell (Gauge)
3-34	22	24
35-48	20	22

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

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

14. Round fittings shall be UNITED MCGILL CORPORATION, VORTEX METAL MANUFACTURING, HAMLIN SHEET METAL, SEMCO MANUFACTURING, LINDAB, INC or EASTERN SHEET METAL.
15. Ductwork shall not be delivered to the job site until just prior to erection. Ductwork with dents or other damages shall not be accepted. Double-wall acoustically-lined ductwork shall be removed from the job site and shall not be used if liner is allowed to become wet to any degree.
16. Rectangular low velocity ductwork shall be constructed from galvanized steel sheets of lock form quality per ASTM A653 with a G90 zinc coating (0.60 oz/ft²), unless otherwise shown on the contract documents. Sheets shall be free of pits, blisters, slivers, and un-galvanized spots.
17. 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 1/2 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.
18. Provide flexible connections of fiberglass between ducts and rooftop unit and air-handling unit connections, fan coil units, 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:
 - a. Indoor: Neoprene coated glass fabric, minimum 30 oz./sq.yd.
 - b. Outdoor: U.V. resistant Hypalon coated glass fabric, minimum 24 oz./sq.yd.

- c. Flexible connections shall be DUCTMATE "ProFlex," DURODYNE "Flexible Duct Connector," KINETICS "KINFLEX," or equal.
19. Space roof mounted duct supports and suspended duct hangers every 4 feet, maximum. Insulated duct shall have saddle hangers. Suspended duct hangers attached to the side of the ductwork are acceptable.
 20. Fabricate ductwork with airtight joints, presenting smooth surface on inside, neatly finished on outside. Unless otherwise indicated, provide square or rectangular elbows and 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. Turning vanes shall be DUCTMATE "ProRail," AERODYNE "H-E-P Turning Vanes," DURODYNE "Vane and Rail" or equal.
 21. Construct, brace, and support ducts and air chambers in a manner that they will neither sag nor vibrate to any perceptible extent when fans are operating at maximum speed or capacity.
 22. Provide sandwich type or square framed access doors for service temperature and pressure required, where indicated and where not indicated, in locations and of sizes which 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. Duct access doors shall be DUCTMATE "Sandwich Access Door," GREENHECK "CAD-10," ACUDOR "CD-5080," or equal.
 23. Connect ductwork to intake and discharge louvers, dampers, and other work installed in various trades requiring sheet-metal connections.
 24. Make sheet-metal connections to masonry work airtight and watertight in approved manner.
 25. Provide opposed-blade dampers for control of air volume and for balancing system, where indicated or required. Dampers shall be of sheet metal at least one gauge heavier than duct and reinforced; shall be installed in an accessible location. Provide indicating quadrant and locking device for adjusting and locking dampers in position. Provide extended shafts on all volume dampers greater than the thickness of the insulation to provide free movement of damper positioner. Stiffen duct at damper location, install damper in manner to prevent rattling.
 26. Where dampers are located above inaccessible ceilings, provide remote cable operated volume damper for control and balancing of air volume. The damper shall be constructed of galvanized steel. The inner wire of the casing shall be stainless steel with tensile strength of 260,000 lbs. For application where the diffuser or grille is installed in hard ceiling below 16'-0" AFF, the adjustable controller shall be installed on either the diffuser or grille face, or mounted to the ceiling surface. Otherwise, provide 50' cable and locate adjustable controller concealed in wall with 3-3/4" cover plate. A list of acceptable manufacturers is listed below:

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Manufacturer	Damper Model	Diffuser/Ceiling Mounted Controller	Wall Mounted Controller
UNITED ENERTECH	BO-RI	BO-150	BO-702
DURODYNE	DuroZone	CSB	WSB
METAIRTECH	RT-250	RT-CCM	RT CCS

27. Provide square to round transition fittings with balancing damper at all round-duct take-offs to supply diffusers and registers.
28. Provide access doors in building walls and ceilings where damper quadrants are concealed in shafts or above non-accessible ceilings.
29. Duct sizes are inside free area. Increase duct sizes as required.
30. Ductwork and accessories shall not be delivered to the job site until just prior to erection and must be stored in an approved manner.
31. All new ductwork shall be internally cleaned by vacuuming prior to installation.
32. All new and existing ductwork open ends shall be sealed with polyethylene and duct tape during construction after hanging.
33. Refer to Specification Section 230885 Duct Cleaning and notes on the drawings for existing ductwork cleaning requirements. All existing ductwork shall be internally cleaned in accordance with Specification Section 230885.

B. Grilles, Registers and Diffusers

1. Refer to drawings for types, material, models, finishes, and manufacturers. Air devices shall have performance characteristics (throw, noise, and pressure drop) equal to air devices scheduled on the drawings. Provide performance data with submittal. PRICE, TITUS, GREENHECK, or equal. Grille and register frames and louvers shall be one-piece construction.
2. Paint interior surfaces of ducts behind grilles and registers with flat black enamel.

2.8 VIBRATION ISOLATION

- A. Mechanical equipment indicated below shall be isolated from the structure by resilient vibration and noise isolators. Equipment to be isolated includes, but is not limited to, the following: Rooftop Units (RTUs).

1. Vibration Isolation Rail System:

- a. Curb mounted rooftop equipment shall be mounted on vibration isolation rails that fit on top of the steel framing and under the isolated equipment. Curb mounted isolation rails shall be Type CMAB as manufactured by MASON INDUSTRIES, INC. or approved equal. Isolation rail system shall be stamped by a registered professional engineer employed by the manufacturer.
- b. The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal.
- c. 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. Hanger and Guide Supports:

- a. All ductwork and piping connected to equipment that has been vibration isolated (RTUs) shall be isolated from the building structure with ceiling spring hangers. Hangers shall be MASON "W30," VIBRO-ACOUSTICS "SHCH," KINETICS "MUTA," or equal.
- b. Spring isolators shall include springs that are seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod to hanger contact. 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. Spring diameters and the lower hole sizes shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing.

B. Neoprene Isolation Pads

1. For all equipment with a fan and/or compressor and mounted on a concrete pad, provide 3/4" (19mm) thick neoprene pads consisting of 2" (50mm) square waffle modules separated horizontally by a 16 (1.5mm) gauge galvanized shim. At a minimum, pads shall be provided under all corners of the equipment, but quantities shall be increased in accordance with the equipment manufacturer's recommendations. Load distribution plates shall be used as required. Pads shall be MASON "SW," VIBRO-ACOUSTICS "Neo +," KINETICS "RSP," or equal.

C. Rooftop Acoustical Systems: Provide acoustical material inside the roof curb as indicated on the Contract Drawings. Acoustical material shall be furnished by the isolation curb manufacturer, and consist of the following:

1. Vibration Isolation Rail System: 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 to attenuate acoustical vibrations translated through the roof curb.
2. Provide 2" thickness ROCKWOOL "AFB," OWENS-CORNING "705," or JOHNS MANVILLE "Insul-SHIELD" acoustic batt insulation with 2.8 lbs./sf density on top of the gypsum board.

2.9 MEASUREMENT AND CONTROL

A. Variable Frequency Drives

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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. Pumps (P-1 through P-6)
 - b. Rooftop Units and Air Handling Units (when not provided by the unit manufacturer).
3. Acceptable VFD manufacturers are ABB, DANFOSS, TOSHIBA, or equal.
4. The VFD package as specified herein shall be enclosed in a UL Listed Type 1 enclosure for indoor applications, completely assembled and tested by the manufacturer in an ISO9001 facility.
 - a. Environmental operating conditions: VFDs shall be capable of continuous operation at 32 to 120 F ambient temperature or VFD must be oversized to meet these temperature requirements.
 - b. Enclosure for indoor applications shall be rated UL Type 1, Enclosures for outdoor applications shall be UL Type 3R. All enclosures shall be UL listed as a plenum rated VFD.
5. All VFDs shall have a Short Circuit Withstand Rating of not less than the rating of the connected equipment in accordance with UL508.
6. All VFDs shall have the following standard features:
 - a. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference.
 - b. There shall be a built-in time clock in the VFD keypad.
 - c. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up.
 - d. The VFD shall have cooling fans that are designed for easy replacement.
 - e. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip.
 - f. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
 - g. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients.
 - h. The input current rating of the VFD shall be no more than 3% greater than the output current rating.
 - i. The VFD shall include a coordinated AC transient surge protection system.
 - j. The VFD shall provide a programmable loss-of-load Form-C relay output.
 - k. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of mechanical failure / jam condition causing motor overload

- l. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control.
 - m. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user.
 - n. Door interlocked, pad lockable molded case switch that will disconnect all input power from the drive and all internally mounted options.
7. All VFDs to have the following adjustments:
 - a. Three (3) programmable critical frequency lockout ranges.
 - b. Two (2) PID Set point controllers allowing pressure or flow signals to be connected to the VFD.
 - c. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (i.e., valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
 - d. Two (2) programmable analog inputs shall accept current or voltage signals.
 - e. Two (2) programmable analog outputs (0-20ma or 4-20 ma).
 - f. Six (6) programmable digital inputs for flexibility in interfacing with external devices.
 - g. Three (3) programmable, digital Form-C relay outputs.
 - h. Run permissive circuit - There shall be a run permissive circuit for damper or valve control.
 - i. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active.
 - j. Seven (7) programmable preset speeds.
 - k. Two independently adjustable accel and decel ramps with 1 - 1800 seconds adjustable time ramps.
 - l. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise.
 - m. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
 - n. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD.
 - o. The VFD shall include password protection against parameter changes.
8. The Keypad shall include a backlit LCD display. All VFD faults shall be displayed in English words. The keypad shall include the following assistants:
 - a. Start-up assistant
 - b. Parameter assistants
 - c. Maintenance assistant
 - d. Troubleshooting assistant

- e. Drive optimizer assistants
9. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times:
- a. Output Frequency
 - b. Motor Speed (RPM, %, or Engineering units)
 - c. Motor Current
 - d. Motor Torque
 - e. Motor Power (kW)
 - f. DC Bus Voltage
 - g. Output Voltage
10. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed. 2) Operate in a specific fireman's override PID algorithm. The mode shall override all other inputs except customer defined safety run interlocks, and force the motor to run in one of the two modes above.
11. Serial Communications
- a. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. Optional protocols for LonWorks, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.
 - b. The BACnet connection shall be an EIA-485, RS/485 interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
 - 1) Data Sharing - Read Property - B.
 - 2) Data Sharing - Write Property - B.
 - 3) Device Management - Dynamic Device Binding (Who-Is; I-Am).
 - 4) Device Management - Dynamic Object Binding (Who-Has; I-Have).
 - 5) Device Management - Communication Control - B.
 - c. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

- d. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.
 - e. The VFD / bypass shall allow the DDC to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function.
 - f. The VFD shall include an independent PID loop for customer use.
12. EMI / RFI filters. All VFD's shall include EMI/RFI filters.
13. All VFD's through 75HP at 480 V shall be protected from input and output power mis-wiring.
14. Bypass Controller
- a. A complete factory wired and tested bypass system shall be provided with the following operators:
 - 1) Bypass Hand-Off-Auto
 - 2) Drive mode selector
 - 3) Bypass mode selector
 - 4) Bypass fault reset
 - b. The bypass shall include an LCD display that allows the user to access owner requested data including but not limited to fails, bypass power (KW), and energy savings.
 - c. The following indicating lights (LED type) or keypad display indications shall be provided.
15. Emergency Stop Function
- a. An emergency stop function shall meet all of the following requirements:
 - 1) The function shall override all other functions and operations under all conditions.
 - 2) Reset must not initiate a restart.
 - 3) An emergency stop shall operate in such a way that, when it is activated, the hazardous movement of the machinery is stopped and the machine is unable to start under any circumstances, even after the emergency stop is released. Releasing the emergency stop only allows the machine to be restarted.
 - 4) The emergency stop shall stop hazardous movement by applying a stop category 0.

- a) Emergency stop category 0 (according to EN 60204-1) means that the power to the motor shall cut off immediately. Stop category 0 is equivalent to the safe torque off (STO) function, as defined by standard EN/IEC 61800-5-2.
- 16. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.
- 17. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current.
- 18. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.
- 19. The VFD Product Warranty shall be 24 months from the date of certified start-up. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

B. Bipolar Ionization

- 1. This section describes the design, performance, and installation of a needlepoint bipolar ionization (NBPI) 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. Project Design
 - a. Maximum ozone emissions shall be in accordance with limits stated in UL 2998. Provide products listed as UL2998-compliant.
 - b. Provide ionization device that does not require preheat protection when relative humidity of entering air exceeds 85%. Device shall be suitable for relative humidity from 0-100%, condensing, without causing damage, deterioration, or dangerous conditions within air ionization system.
 - c. Provide systems that produce positive and negative ions. Unipolar ionization devices are unacceptable.
 - d. Device shall be tested by UL, proving compliance with UL 2998 ozone standard when tested using UL 867 (5th edition) methodology. Perform large chamber testing and peak ozone test for electronic devices in accordance with UL 2998.
 - 1) Demonstrate interior ion concentration levels, both positive and negative collectively, to minimum 2000 ions/cc measured 5 ft from floor where air is delivered from the duct system
 - 2) Provide ionization systems suitable for air exchange rates through full operating range of constant volume or variable air volume (VAV) system.
 - 3) Minimum air velocity: 300 fpm
 - e. Provide ionization device enclosures constructed of corrosion-resistant, non-metallic materials. Configure enclosure without thermal bridging. Provide units certified to UL 2998.

- f. Provide ionization units having manufacturer's recommended number of electrodes and power generators, sized to system air flow.
 - g. Electrodes shall consist of carbon fiber clusters having minimum 45000 needles each.
 - h. Ionization system shall be energized continuously.
 - i. Additional Design Requirements for Non-Auto Coil Cleaning Installations:
 - 1) Multi-voltage input shall allow 24V or 110-240VAC power supply.
 - 2) Provide magnets for mounting ionization system to fan inlet.
 - 3) Provide integral alarm dry contacts, SPST (NO), rated 0.3 A at 125VAC.
 - j. Additional Design Requirements for Auto Coil Cleaning Installations:
 - 1) Provide electrodes in six-inch sections for field assembly by installer to cover entire finned width of coil.
 - 2) Provide one modular ionization bar for every 5ft. of coil height.
 - 3) Electrode spacing shall be 0.5 to 1 inch apart.
 - 4) Output shall be 140 million ions/cc per inch of bar, measured 1 inch from carbon fiber brushes.
 - 5) Ionization Bars:
 - a) Length shall be 12 ft. maximum
 - b) Provide ac power supply for field installation, capable of powering four ionization bars requiring 20W each.
 - c) Include integral on/off switch and LED "power on" light.
 - d) Include BAS interface alarm dry contacts, SPST (NO), rated 1A at 250VAC.
 - e) Power source shall be 24VAC, 110VAC, or 208-240VAC.
 - f) Power supply enclosure class shall be NEMA 250, Type 4.
 - k. NPBI devices shall be provided with internal short-circuit protection, overload protection, and automatic fault reset circuit breakers.
3. General Installation
- a. Position each electronic air cleaner unit with clearance for service and maintenance. Anchor electronic air cleaners to substrate.
 - b. Install air cleaner devices between upstream filter and cooling coil. Where unit configuration does not allow this installation location, air cleaner devices shall be installed upstream or downstream of supply fan.
4. Factory-fabricated, modular bipolar ionization device
- a. Subject to compliance with requirements, provide GPS "i-MOD," PHENOMENAL AIRE "Series C Universal," ATMOSAIR "ActiveOx R" or equal.
 - b. Capacity and Characteristics
 - 1) Materials: Composite and carbon fiber
 - 2) Capacity: 50 to 250 cfm per inch of length
 - 3) Voltage selector switch and illuminated on-off switch

- 4) LED operational status light
- 5) Six high-voltage output connections
- 6) Alarm contacts: SPDT, dry
- 7) Auxiliary terminals for connections of remote ion sensor
- 8) Temperature range: -40°F to 140°F
- 9) Relative humidity range: 0-100%
- 10) Power Entry: UL listed, line cord with three-prong plug
- 11) Power unit dimensions: 9" L x 3.25" W x 4.75"H
- 12) Ionizer bar dimensions: 1.6"H x 0.75" W
 - a) Length per section: 6 inches, having nine brushes per section
 - b) Maximum assembled bar length: 144 inches
 - c) Provide rare earth magnets for mounting
- 13) Power unit weight: 4.63lb
- 14) Ionizer bar weight: 0.24lb per 6-inch section

c. Electrical Characteristics

- 1) Electrical Listings: UL/ETL
- 2) Compliance and Certifications: IAQP, UL 867, UL 2043, UL 2998
- 3) Input voltage: 24V AC or DC, 110VAC, 240VAC
- 4) Amperes: 0.5A at 24V, 0.12A at 110V, 0.1A at 240V
- 5) Output power: 5 kV RMS
- 6) Total ion output: 140 million ions/cc per inch of bar, measured 1 inch from carbon fiber brushes

d. Provide ion sensor compatible with ionization device.

e. Provide one ionization bar assembly on each coil up to 60 inches in height. Space bars maximum 60 inches apart. Install bar to cover entire finned width of coil to nearest 6 inches without exceeding finned width of coil.

5. NPBI device for unit mounting

- a. Subject to compliance with requirements, provide GPS "FC3-BAS," ATMOSAIR "ActiveOx FC," PHENOMENAL AIRE "Series D 3.2" or equal.
- b. Capacity and Characteristics

- 1) Materials: Carbon fiber ion emitters
- 2) Capacity: 0 to 1200 cfm
- 3) Provide integral alarm dry contacts, SPST (NO), rated 0.1A at 24VAC.
- 4) Temperature range: -40°F to 140°F
- 5) Relative humidity range: 0-100%
- 6) Unit dimensions: 2.6" L x 1.9" W x 1.3"H
- 7) Unit weight: 0.23lb

c. Electrical Characteristics

- 1) Electrical Listings: UL

- 2) Compliance and Certifications: IAQP, UL 867, UL 2998
 - 3) Input voltage: 24V AC or DC, 110VAC, 240VAC
 - 4) Power Consumption: 1.2W
 - 4) Output power: 2 kV RMS
 - 6) Total ion output: 35 million ions/cc per foot, measured 1 inch from carbon fiber brushes
- d. Install ionization emitter perpendicular to air flow direction. Mount so ion emitters are exposed to, and perpendicular to, airstream. Mount ion emitters so airflow passes between them.
- 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 "AquaGuard," LITTLE GIANT "ACS-2," ASURITY "CC-1," or equal.
 2. 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. Switch shall be RECTORSEAL "Safe-T-Switch," LITTLE GIANT "ACS-5," ASURITY "CS-1," or equal.
 3. 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.
 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 front-end workstation. The mechanical contractor shall be responsible for coordinating the switch connections with the controls contractor.
 6. The switch shall be UL Listed to comply with UL 508.

PART 3 - EXECUTION

3.1 TESTS

- A. Refer to Section 230593 "Testing, Adjusting and Balancing" for related requirements.
- B. At their discretion the Owner shall be represented at all tests. Contractor shall provide 48 hours' notice to the Owner prior to the tests unless otherwise specified.
- C. Before insulation is installed and before piping is concealed, test water piping hydrostatically and prove tight under 100 psig pressure. Test pressure shall be held for minimum of 8 hours. An air test in lieu of water may be used when danger of freezing is possible and when approved.

- D. 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 to the manufacturer's recommended procedures, alignment completed prior to shipment is not acceptable. After the equipment has been aligned, the contractor shall provide a written report verifying that the pumps vertical and horizontal angularity and parallel offset gap are within one of the following tolerances:
 - 1. Pump parallel offset gap shall be within 1/64" at operating speed and pump angularity shall be within 1/64" per inch of coupler radius.
 - 2. The manufacturer's recommended tolerance for the application and with the Engineer's approval.
- F. Test all gas piping at 50 psig with oil-free compressed air for 2 hours with no loss in pressure.

3.2 EQUIPMENT COORDINATION

- A. The Prime contractor shall conduct an HVAC Coordination meeting after submission of the HVAC equipment, fire alarm, and controls submittals to the Engineer, and prior to the return of the reviewed controls submittal to the Prime Contractor. The Prime Contractor shall coordinate the meeting time, date, and location with all parties, provide a written agenda, provide written meeting minutes, and provide a detailed issues summary (if unresolved issues remain open after the meeting).
- B. The Prime Contractor shall provide follow-up action as required with the following in mandatory attendance:
 - 1. Prime Contractor Project Manager and Project Superintendent
 - 2. Equipment manufacturer technical services representative (not a sales representative)
 - 3. Controls contractor technical services representative (not a sales representative)
 - 4. Mechanical engineer
 - 5. Owner's representative
 - 6. Fire alarm system representative
- C. The purpose of this meeting is to review equipment, control sequences, and the selected manufacturer's available control points. Upon completion of this meeting, the General Contractor shall be required to submit a meeting report detailing all discussed issues and coordinated solutions. Any unresolved issues shall require another mandatory meeting to ensure all items have been considered and coordinated prior to construction.

END OF SECTION 230500

SECTION 230593 - TESTING, ADJUSTING AND BALANCING (TAB)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 "Mechanical General Provisions" apply to this Section.

1.2 SCOPE OF WORK

- A. The General Contractor shall obtain the services of an independent testing and balancing agency whose business is limited to testing, adjusting and balancing and shall be certified by AABC (or NEBB). Agency shall have been in the TAB business for a minimum of 5 years. The TAB (Testing, Adjusting and Balancing) Agency shall be a direct subcontractor of the General Contractor and not affiliated in any way with the Mechanical Contractor.
- B. Testing and balancing shall be performed in accordance with National Standards for Testing and Balancing Heating, Ventilating and Air-conditioning Systems, 2002, as published by Associated Air Balance Council (AABC).
- C. All work shall be performed under the direct supervision of a certified TAB Engineer. All other personnel shall be regular full-time employees of the TAB Agency.
- D. Test and Balance Agency shall submit within 30 days after receipt of construction contract two copies of qualifications, including current TAB Engineer's certificate and National Project Certification Performance Guaranty.
- E. TAB work shall not commence until all components of the HVAC system have been installed completely per project phase. This shall include 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 $\pm 10\%$ of their respective design quantities of flow.
- D. Determination of the air volumes shall be made by pitot tube and differential draft gauge for all supply, return, outdoor air and exhaust air ducts. Openings for pitot traverses shall be provided as required and shall be fitted with neat removable plugs or covers. Air quantities at grilles, registers, diffusers, etc., shall be measured as recommended by the various manufacturers of the outlets.
 - 1. VAV boxes shall be balanced in a manner that assures the design primary airflow is delivered to the VAV box at maximum and minimum air flow. The manufacturer provided flow measurement device may or may not be accurate due to upstream duct conditions. (see 3.2.H.7 for reporting requirements)
- E. The Test and Balance Agency shall perform the following:
 - 1. Adjust fan RPM, tighten and align fan belts, measure operating amps.
 - 2. Adjust volume dampers to obtain designed air volume.
 - 3. Adjust grilles, diffusers and registers to obtain designed airflow and air pattern.
 - 4. Set balancing valves to obtain designed water flow at units, coils and branches.
 - 5. Adjust each air handler to obtain designed airflow.

6. Adjust dampers to provide design outside air quantities.
 7. Adjust airflow exhausted from and supplied to hoods.
 8. In cooperation with the ATC Contractor's representative, setting adjustments of automatically controlled dampers to operate as specified. The TAB Agency shall inform ATC Contractor of all abnormalities in sequencing and/or calibration of components discovered during balancing.
 9. Final settings of dampers and valves shall be permanently marked. Where provided, memory stops and locking devices shall be adjusted and locked to the final setting.
 10. Assist Fire Alarm Contractor in the testing of all duct smoke detectors. Measure the air velocity across each duct smoke detector with air handling unit at full airflow.
- F. Before the work is offered for Final Acceptance, all equipment shall be run through a test to demonstrate that it has been adjusted to meet the requirements of the drawings and Specifications. Copies of the test and adjustment data shall be submitted in a report to the Owner's Representative prior to final inspection.
- G. The TAB Report shall include a General Comments section providing an overview of systems operation, observations of system installation abnormalities and deficiencies, problems encountered, etc. If required, provide explanation of methods of measurement and disparity between measured and design quantities.
- H. Test and Balance Agency Report shall include the following data for each system. All sheets shall be neatly typed. Balancing Agency shall submit with his report a set of neatly marked plans identifying location of each piece of equipment, air terminal, flow measuring device and points of traverse. Report all measured quantities and design quantities where applicable.
1. CFM of each supply, return, exhaust grille and diffuser.
 2. RPM and CFM of each fan.
 3. Supply, return and outdoor air CFM of each AHU and fan terminal unit where required.
 4. Air pressure drop across A/C unit cooling coils.
 5. Air pressure drop across each filter bank.
 6. Discharge and suction static pressure of each fan.
 7. Maximum and minimum differential pressure and corresponding CFM of each terminal box.
 8. Voltage rating and operating volts of each fan motor. For fan motors requiring three-phase power, record voltage of each individual phased leg and check for voltage imbalance.
 9. Temperatures and pressures for each boiler 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 and energy wheel.
 - b. Entering and Leaving hot water temperature at each reheat, heating, and preheat coil.

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11. Air Handling unit is defined as any equipment that consists of a fan and coil, including rooftop units.
 12. Nameplate data of each piece of HVAC equipment installed.
 13. GPM of each pump and corresponding suction and discharge pressure.
 14. 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.
 15. Amp rating and operating amps of each pump. For pump motors requiring three-phase power, record amps of each individual phase.
 16. Differential pressure and corresponding GPM across each flow measuring device, including automatic flow control devices.
 17. Final percent setting after adjustment of each balancing valve where applicable.
 18. 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 $\pm 5\%$ of submitted data, the Owner's Representative may void entire report and ask for complete rebalancing. The field check shall be made within 45 days of approved TAB submittal.

END OF SECTION 230593

SECTION 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 "Mechanical General Provisions" apply to this Section.

1.2 SUBMITTALS

- A. Submit manufacturers' data on all insulation products, schedule which indicates where each product is to be used and thickness of each product.

1.3 WARRANTY-GUARANTEE

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

PART 2 - PRODUCTS

2.1 INSULATION – GENERAL

- A. All insulation shall have a composite (insulation, jacket or facing and adhesive used to adhere the facing or jacket to the insulation) fire and smoke rating as requested by ASTM E84, NFPA 255 and UL 723, not exceeding:

Flame spread	25
Smoke developed	50

- B. Accessories, such as adhesive, mastics, cements, tapes and fire-resistant cloth for fittings, shall have same fire and smoke ratings as components listed above.
- C. Installation of insulation shall be accomplished in strict accordance with manufacturer's recommendations and shall be CERTAINTEED, OWENS-CORNING, JOHNS MANVILLE or KNAUF INSULATION for glass fiber insulation; ARMACELL for flexible unicellular insulation.

2.2 PIPE INSULATION

- A. Glass fiber insulation having a thermal conductivity not greater than 0.24 Btu x in./hr. x sq. ft. x °F in a mean temperature of 75°F. Insulation shall have factory-applied all-purpose jacket.
- B. Flexible unicellular insulation having a thermal conductivity not greater than 0.27 Btu x in./hr. x sq. ft. x °F in a mean temperature of 75°F.

2.3 DUCT INSULATION

- A. Blanket Type within the conditioned space: Glass fiber, ¾-lbs/cu. ft., foil faced, vapor-sealed flexible duct insulation. Thermal conductivity shall not exceed 0.29 Btu x in./hr. x sq. ft. x °F.
- B. Board Type within the conditioned space: Glass fiber, 3.0-lbs./cu. ft., foil faced, vapor-sealed board insulation. Thermal conductivity shall not exceed 0.23 Btu x in./hr. x sq. ft. x °F.
- C. Blanket Type in unconditioned space or outside building: Glass fiber, 1-1/2-lbs/cu. ft., foil faced, vapor-sealed flexible duct insulation. Thermal conductivity shall not exceed 0.25 Btu x in./hr. x sq. ft. x °F.
- D. Board Type in unconditioned space or outside building: Glass fiber, 3.0-lbs./cu. ft., foil faced, vapor-sealed board insulation. Thermal conductivity shall not exceed 0.23 Btu x in./hr. x sq. ft. x °F.

2.4 ACOUSTIC DUCT LINER

- A. Fiberglass duct liner shall not be used.

2.5 INSULATED DUCT COATING

- A. Provide insulated duct coating on all exterior galvanized sheet metal ductwork, POLAR SEAL, ASTEC, or approved equal.
 - 1. Water based acrylic plastic primer “prime security” shall provide 100% adhesion to substrate, stop oil migration and set base for waterproof membrane “top security”.
 - 2. Water-based acrylic plastic waterproof membrane “top security” with bright white reflective heat shield consisting of a high concentrate of titanium dioxide to reflect ultraviolet rays.
 - 3. Membrane “top security” shall be non-chalking, mildew and fungus resistant and crack resistant.
 - 4. Membrane “top security” shall be capable of withstanding sub-zero and extreme heat conditions without degradation. Membrane shall not shrink or become brittle because of age. Membrane shall be resistant to environmental pollution and other chemicals, such as ammonia, chlorine, insecticides, herbicides and other common airborne chemicals.

2.6 HOT VESSELS

- A. 3 lbs./cu. ft. density, glass fiber, semi-rigid board with all service jacket.

2.7 ALUMINUM PIPE JACKETS

- A. Aluminum jacket shall be .016" thick (28 ga.) smooth aluminum sized to provide a minimum 2" self-gauging overlap longitudinal and circumferentially, minimum 3/4" by .015" thick (30 ga.) draw bands. Jacket shall be supplied with a factory-applied polykraft moisture barrier. CHILDERS PRODUCTS COMPANY, STRAP-ON JACKETING.
- B. Provide fitting covers of same material as jacket and of same manufacturer.

2.8 CALCIUM SILICATE PIPE INSULATION INSERTS

- A. Calcium silicate meeting ASTM C533, Type I, water resistant; rigid molded pipe; asbestos-free JOHNS MANVILLE Thermo-1200, or approved equal.
- B. Thermal conductivity of 0.437 Btu at 300°F mean temperature as tested in accordance with ASTM C335.
- C. Minimum compressive strength of 100 psi to produce 5% compression at 1-1/2" thickness.
- D. Non-combustible as determined by test complying with ASTM E136.
- E. Inserts shall have sufficient compressive strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation. Insulation inserts shall cover the bottom half of the pipe circumference 180 degrees and be not less in length than the protection shield. Vapor-barrier facing of the insert shall be of the same material as the facing on the adjacent insulation.

2.9 PVC PIPE JACKET FITTING COVERS

- A. One-piece molded-type PVC plastic fitting covers and jacketing material, color matching JOHNS MANVILLE Zeston 2000, or approved equal.
- B. Connections shall be made using pressure-sensitive color matching vinyl tape.

2.10 COLOR CODED PVC PIPE JACKETS

- A. PVC jackets shall be 28 or 30 mm thick smooth PVC sized to provide a minimum 2" self-gauging overlap, longitudinal and circumferentially. Joints shall be solvent welded.
- B. Jackets shall have a smoke developed value of 50 or less and a flame spread value of 25 or less.

- C. Jackets shall come supplied from the manufacturer color coded in accordance with color code schedule below.
- D. Jackets shall be manufactured by JOHNS MANVILLE model "Zeston 2000", P. I. C. PLASTICS, INC., "FG 30" or approved equal.
- E. Jackets for grooved pipe fittings shall be manufactured by PROTO FITTING COVERS or approved equal.
- F. Provide fitting covers of same material as jacket and of same manufacturer.
- G. Color Code Schedule (Johns Manville used as basis for colors):
 - 1. Gas – Yellow
 - 2. Heating Hot Water Supply and Return – Orange
 - 3. Chemical Feed - Match color of system served

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.

3.2 PIPING (GLASS FIBER INSULATION, UNLESS OTHERWISE NOTED)

- A. Schedule:

Domestic Cold Water	1/2" thickness for pipe sizes up to 1-1/4" 1" thickness for pipe sizes over 1-1/4"
Hot Water Heating Water (140°F and above)	1-1/2" thickness for pipe sizes up to 1-1/2" 2" thickness for pipe sizes over 1-1/2"
Chemical Feed	1/2" thickness flexible unicellular
Refrigerant Piping	1/2" thickness flexible unicellular for all liquid piping. 1" thickness flexible unicellular for vapor (suction) piping up to 1-1/2". 1-1/2" thickness flexible unicellular for vapor (suction) piping over 1-1/2".

Condensate drain above floor 1/2" thickness

- 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. Fittings and valves on refrigerant suction piping shall be insulated with cut sections of flexible unicellular insulation of thickness equal to adjoining pipe insulation.
- D. All flexible unicellular and glass fiber piping insulation exposed to the weather shall be provided with PVC jacketing.
- E. No piping shall be insulated until it has been tested and thoroughly cleaned.
- F. Insulate all hot water piping above the roof line, including inside of outdoor air-handling units. Apply over heat-trace tape.
- G. 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
8" to 10" pipe size	16" long
12" and above	22" long

3.3 DUCTWORK

- A. Definitions:
 - 1. Concealed: Ductwork which shall be hidden from view by ceilings, walls, chases, or soffits, either by the work of this Contract, or by future tenant build-out work.
 - 2. Exposed: Ductwork which is permanently in view, typically found in mechanical, storage, electrical, or other unfinished space.
- B. Schedule:
 - 1. Definitions:
 - a. Concealed: Ductwork which shall be hidden from view by ceilings, walls, chases, or soffits, either by the work of this Contract, or by future tenant build-out work.
 - b. Exposed: Ductwork which is permanently in view, typically found in mechanical, storage, electrical, or other unfinished space.
 - c. Unconditioned space: Any area not directly served by supply ductwork. Plenum spaces shall be considered conditioned. Attics, mezzanines, and mechanical rooms shall all be considered unconditioned

C. Schedule:

Concealed Supply, Return, Relief and Outside Air Ductwork Externally Insulated: (inside the conditioned space)	2" thickness blanket
Exposed Supply, Return, Relief and Outside Air Ductwork Externally Insulated: (outside building and in all mechanical rooms and mechanical mezzanines)	2" thickness rigid board
Plenums:	2" thickness (or externally insulate with 2" blanket or 1-1/2" rigid board)
Transfer Ducts:	Not Required
Exhaust Ducts:	Not Required
Factory Insulated Casings and Plenums	Not Required
Factory Insulated Double Wall Ductwork	Not Required

- D. Insulate necks and tops of all supply air diffusers, registers and grilles.
- E. Finish all edges of insulation with mastic sealant to ensure no insulation is exposed, where installed outdoors or in unconditioned spaces.
- F. Where installed in conditioned spaces, blanket-type insulation shall be stapled and taped in accordance with manufacturer's instructions. Tape all edges of insulation to ensure that no insulation is exposed.
- G. Insulation on ductwork over 16" in height or width must be attached with stick pins. When using self-adhesive pins, prepare surface to be applied to ensure adhesion.

3.4 SELF-ADHESIVE, FIELD-APPLIED, OUTDOOR JACKETS

- A. Ducts shall be sealed in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible - Second Edition (1995) Seal Class B (or latest version of SMACNA) prior to installation of insulation and the outdoor, field-applied jacket.
- B. Outdoor, field-applied insulation and jacket on ductwork insulation shall be pitched to shed water and prevent water ponding on top of the duct.
- C. Fiberglass insulations shall have a factory applied FSK facing. Contractor shall be responsible for testing adhesion to any substrate.
- D. Substrate surfaces shall be clean, dry, and free of oil films.

- E. Select outdoor, field-applied jacket materials in accordance with manufacturer's instructions for coverage on the underside of the ductwork, to avoid pins.
 - F. Contractor shall adhere to the following duct installation criteria for proper maintenance of vapor barrier and physical integrity:
 - 1. Board insulation shall be mechanically installed on properly sealed ductwork according to the specifications using insulation fasteners (mini-cup weld pins or perforated, based pins and washers).
 - 2. Washers shall be covered with a 4-inch square piece of smooth foil tape prior to jacketing the ductwork to prevent the puncture of the outer membrane by the fasteners.
 - 3. Insulation on the top of the ductwork shall be installed to allow for the water to shed from the top of the duct and to prevent water from ponding on the top of the duct.
 - G. Contractor shall follow one of the options below for the installation of the outdoor, field-applied jacket depending on the jacket product and the duct sizes:
 - 1. Two-Piece Installation.
 - 2. Four-Piece Installation.
 - H. Contractor shall protect outdoor, field-applied jackets from damaging chemicals. Solvation will occur to the rubberized bitumen when exposed to petroleum or coal tar based compounds. Contact the manufacturer immediately for more information if there is doubt, before any chemical interaction.
 - I. Contractor shall allow each piece of the outdoor, field-applied jacket to stretch by using a 6-inch lap over the circumferential lap, and a 4-inch wide butt lap or overlap over the joint, and then roll with a roller. Position longitudinal laps at a water shed position.
 - J. Contractor shall not pre-apply the outdoor, field-applied jacket to fabricated insulation unless metal banding is used. Outdoor, field-applied jackets are not mechanical fastening systems and will not hold the insulation on the duct.
- 3.5 HOT VESSELS
- A. Schedule:

Hot Water Air/Dirt Separator	2" thickness, rigid fiberglass
Hydronic Expansion Tank	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.

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- 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. 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 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:

All HVAC systems
Rooftop Units (RTU's)
Air Handling Units (AHU's)
Condensing Units (CU's)
Existing Variable Air Volume Terminal Units
Hydronic hot water system including boilers (B-1,2,3 & 4)
HVAC pumps P-1 through P-6 and related VFD's.
Data Room system (SS-1/OU-4)
Exhaust Fans
Ductless Split System Heat Pumps (IU/OU-1, 2 & 3)

1.3 COMMISSIONING OBJECTIVES

- A. To ensure that all building systems, subsystems, equipment, controls, and interfaces with other building systems are installed, tested, and are operating in compliance with Contract Documents and within the scope of design requirements.
- B. To ensure that all system operation and maintenance personnel are properly instructed to effectively and efficiently operate and maintain the systems, subsystems, equipment, and controls, and that they will receive all required manuals and documentation.
- C. The Commissioning Agent shall provide the following to the Contractor for implementation and execution.

1. Commissioning Plan: The Commissioning Agent shall prepare the Commissioning Plan in accordance with contents as specified herein.
2. Checklists and Test Forms: The Commissioning Agent shall prepare the Pre-Functional Checklists and Functional Performance Test Forms, specifically for this project, and edited to suit the equipment and systems installed.
3. Submittals:
 - a. The Contractor shall submit the following documents to the Commissioning Agent for review and inclusion in the Commissioning Plan.
 - i. Piping pressure and vacuum test reports
 - ii. Equipment startup reports
 - iii. DALT report
 - iv. TABs report
 - v. HVAC Water quality test report
 - vi. Prefunctional Checklists completed by the installing Foreman.
 - vii. O&M Manuals with warranties
 - viii. Training class agenda and schedule
 - b. Commissioning Report: The Commissioning Agent shall assemble the final Commissioning Report comprised of completed prefunctional and functional checklists, equipment startup test reports, etc. organized by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

1.4 REFERENCED STANDARDS

- A. ASHRAE 90.1-2016, 6.7.2.4
- B. NEBB, "Procedural Standards for Building Systems Commissioning."
- C. SMACNA, "HVAC Systems Commissioning Manual."

1.5 COMMISSIONING TEAM

- A. The Contractor shall designate team members from each of the following to participate in the Commissioning Process (both pre- and post-occupancy):
 1. General Contractor
 2. Mechanical Subcontractor (and HVAC startup technicians)
 3. Electrical Subcontractor
 4. Testing, Adjusting and Balancing (TAB) Subcontractor
 5. Automatic Temperature Controls Subcontractor
- B. The Owner shall designate a representative to participate in the Commissioning Process.

- C. Each of the team member's names shall be submitted in writing to the Commissioning Agent for inclusion in the Commissioning Plan.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 IMPLEMENTATION OF COMMISSIONING PLAN

- A. Plan Submittal: After the start of construction, the Commissioning Agent shall provide the Commissioning Plan to the Contractor for implementation and execution. The Plan shall provide the scope of commissioning tasks to the appropriate parties. Typical elements of the Plan shall include the following:
1. Commissioning Agent's preparation of the Commissioning Test Schedule and distribution to the Contractor and Owner.
 2. Commissioning Agent visits to the job site to observe installation activities.
 3. Contractor's pre-startup verification and completion of the Pre-functional Checklists.
 4. Contractor's submittal of equipment and systems startup verification to the Commissioning Agent.
 5. Contractor's submittal of testing, adjusting, and balancing (TAB) reports to the Commissioning Agent.
 6. Contractor's functional performance testing with the Commissioning Agent.
 7. Contractor's completion of operating and maintenance manuals and submittal to the Commissioning Agent.
 8. Contractor's operation and maintenance personnel instruction.
 9. Commissioning Agent's preparation of the Final Commissioning Report and submission to Owner.
 10. Owner acceptance
- B. Equipment and Systems Startup:
1. Pre-startup Verification: Prior to startup of equipment and systems, the Contractor shall indicate on the pre-start checklists and Commissioning Agent shall observe and verify that all items have been substantially installed in accordance with the project Contract Documents, including all change orders. Verification of the basic installation testing of systems shall be performed by the Contractor and shall include:
 - a. Hydrostatic testing of hydronic piping systems
 - b. Cleaning, flushing, and venting of piping systems, including removal and cleaning of all strainers
 - c. Cleaning of equipment and systems of construction dirt and debris, including replacement of filters, and all items per the approved checklists

2. Startup Verification: The Contractor shall indicate on the startup checklists, and Commissioning Agent shall verify that all HVAC equipment, systems, and subsystems have been activated and operate substantially in accordance with Contract Documents, with all equipment, system, and electrical operating and safety devices checked and functional. The Contractor's work also includes but is not limited to:
 - a. Calibration and testing of all automatic temperature control devices and building automation systems.
 - b. Testing and verification of all interlocks and interfacing between HVAC equipment, systems, subsystems, and other building systems.
 - c. Completion of testing, adjusting, and balancing (TAB) work, including the rechecking of 10% of the measurements.
3. Startup Documentation: Completed startup checklists shall be filled out by the Contractor after startup verification of each HVAC system, subsystem or each item of HVAC equipment. Startup checklists used by the Contractor Technicians shall be neat and typed using standard formats appropriate for the equipment. At the request of the Owner, Contractor shall provide trend data demonstrating equipment has been started and is operating within design parameters.
4. Notification: The Commissioning Agent shall notify the Owner and Contractor when the startup verification has been completed and the HVAC functional performance testing can be started.

3.2 FUNCTIONAL PERFORMANCE TESTING

- A. Purpose: Every item of equipment, all systems and subsystems, controls, and all related equipment shall be tested and evaluated for conformance to performance data in the Contract Documents. Included is conformance to:
 1. Equipment input and output capacities.
 2. Systems and subsystems flow and distribution performance.
 3. Control system performance, accuracy, and adherence to sequences of operation.
 4. Minimum or part load operations and performance.
 5. Interface with other equipment and/or systems.
- B. Equipment Testing: Equipment functional performance testing shall not begin until the following notification of completion has been given to the Owner by the Commissioning Agent.
 1. Copies of the manufacturer's equipment start up reports are submitted to the Engineer for review and approval.
 2. Copies of the commissioning pre-start up and start up reports are submitted to the Engineer and Owner for review and approval.
 3. 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

COMMISSIONING PLAN

MENCHVILLE HIGH SCHOOL HVAC REPLACEMENT



Project No. **23-065**

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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 without 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

[OWNER PM AND TITLE]
[DEPARTMENT AND JURISDICTION]
[ADDRESS 1]
[ADDRESS 2]
[CONTACT #]

Architect

[ARCHITECT PM AND TITLE]
[ARCHITECT FIRM]
[ADDRESS 1]
[ADDRESS 2]
[CONTACT #]

Mechanical Engineer

Kevin Allen, P.E.
Thompson Consulting Engineers
22 Enterprise Parkway, Suite 120
Hampton, VA 23666
(757) 599-4415

General Contractor

TO BE DETERMINED

Mechanical Contractor

TO BE DETERMINED

Controls Contractor

TO BE DETERMINED

TABs Contractor

TO BE DETERMINED

SECTION 230885 - DUCT CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Construction Contract General Conditions, Contract Forms, other Division-I 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 all existing ductwork to remain. This includes all medium pressure and low velocity ductwork shown on the drawings. Refer to the drawings for addition duct cleaning details.
- 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 (medium pressure and low velocity, the interior of a variable air volume terminal units and supply air diffusers and return air ducts to all rooftop units 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 that will not potentially damage the integrity of the ductwork, nor damage porous surface materials, such as liners inside the ductwork or system components.

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. Original construction drawings shall be made available by the Owner upon request of the Contractor. Existing BAS record drawings can be found in Appendix A.
- C. Intended modifications to be made to the existing building controls architecture are shown on Contract Drawings M-501 through M-507.

1.2 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.

1.3 APPROVAL OF MATERIALS AND EQUIPMENT

- A. Within 30 days after award of the Contract and before any purchases are made, submit for approval a complete list of materials 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 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.

1.4 SUPERVISION

- A. The controls contractor 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.

1.5 NOTICES AND FEES

- A. Give all required notices, obtain all necessary permits and pay all required fees.

1.6 DEFINITIONS

- A. TRIDIUM: American engineering hardware and software company and developer of Niagara Framework.
- B. NIAGARA: Universal software infrastructure developed by Tridium Inc. that allows building controls integrators to build custom, web-enabled applications for accessing, automating and controlling smart devices in real-time via local network or over the Internet.
- C. BACnet: Communications protocol for Building Automation and Control (BAC) networks which provides mechanisms for building automation devices to exchange information, regardless of the particular building service they perform.
- D. JACE: Java Application Control Engine. A JACE is a mechanism/device that provides connectivity to systems within a building via the Niagara framework, and can connect common network protocols (BACnet, Modbus, etc.) to provide a seamless, unified controls system.
- E. DDC: Direct digital controls system. A building DDC system, typically hierarchical, consists of terminal controllers (typically factory-provided and shipped with equipment), system/field controllers (typically provided and installed by controls contractors), and a central workstation to provide a user interface for the various building controls.
- F. Front End: System/building level controller(s) that receive data from terminal controllers throughout the building control system.
- G. Controls Integration: The process of providing a Niagara-based front end, to which all other existing terminal controllers communicate.
- H. Controls Replacement: The process of providing new system/building level controllers, as well as providing new terminal controllers for all building HVAC equipment. All new controllers shall be open protocol and capable of communicating with the Niagara N4 supervising server located at NNPS plant

1.7 SYSTEM DESCRIPTION

- A. Overview: 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 HVAC Equipment and existing VAV's at Menchville High School. All new and existing equipment controllers shall be integrated into the Tridium Niagara N4 system architecture for Menchville High 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 controls at Menchville High School with the Niagara N4 supervising server located at NNPS plant. **All HVAC equipment, including equipment not being replaced, shall be fully commissioned. Equipment must operate in accordance with the original or revised sequence of operations. Refer to Appendix A for existing sequences.**

- B. Protocols: NNPS standard is to utilize BACnet protocol within the building control system. BACnet factory supplied onboard controllers shall be in their “native” open protocol, avoiding the need for gateways or translators. There may be some instances where a gateway or translator is the only method to integrate a controller, but those shall be submitted to and approved by the consultant engineer on a case-by-case basis.
- C. DDC Controllers: The building control system will consist of DDC controllers that can stand-alone operate each piece of HVAC equipment (existing and new) or an HVAC system (existing and new) without the use of more than one (1) controller per equipment or system. The DDC controllers will be a combination of factory supplied controllers and control contractor provided and field installed controllers. The coordination of factory controllers vs. field controllers, sensors and integration will be the responsibility of the controls contractor to coordinate with the HVAC equipment providers. Reuse existing controllers where possible. Refer to Appendix A in this section for existing controls record drawings to be used as a basis of system architecture and organization.
- 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:

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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 the Menchville High 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 building.
 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. Each JACE or equivalent controller 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 one (1) 5 year maintenance support agreement for a total of 5 years of coverage, to begin after the initial 18 month support agreement expires. The agreement ownership shall be transferred to NNPS.
- N. Existing Overrides and Side-Loops:

1. It shall be noted that scheduling and sequences of operation for miscellaneous unitary equipment (exhaust fans serving gang toilets, split systems, etc.) may currently reside on Building Controllers or DDC Equipment Controllers. Upon replacement of Building Controllers or DDC Equipment Controllers, all existing schedules and sequences shall be re-written.
- O. All legacy controls, components, and accessories removed or replaced during the course of work shall be turned over to the Owner for use as spare parts. The Contractor shall ensure these items are labeled, organized, and delivered in good condition.

1.8 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. Prior to submitting shop drawings, the Controls Contractor shall lead a coordination meeting between General Contractor, Engineer and Owner to plan the integration of all new system, building, and DDC 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.
- I. The naming conventions used for this project are provided in Appendix A. No deviations are permitted without express approval of the Engineer.

1.9 WORK BY OTHERS

- A. The Automatic Temperature Controls Contractor shall provide the required branch circuitry (conduit and conductors) between each HVAC Control Panel and electrical panels with spare breakers labeled as "HVAC Controls". The Automatic Temperature Controls Contractor shall

coordinate this work with the electrical contractor. Termination at circuit breakers shall be performed by the electrical contractor.

- B. 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.
- C. The Electrical Contractor shall be responsible for wiring of any electrical sub-metering devices furnished by BAS manufacturer.

1.10 SUBMITTALS

- A. Submit three 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.

1.11 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 2 hours of the time that the problem is reported.

PART 2 - PRODUCTS

2.1 PRE-APPROVED CONTROL CONTRACTORS

- A. Subject to compliance with requirements of the project documents to provide a complete building control system by one of the following preferred licensed Authorized Control Integrator (ACI) contractor companies:
 - 1. Honeywell (by Chesapeake Controls)
 - 2. Johnson Controls (by the local branch office of Johnson Controls)
 - 3. Siemens (by the local branch office of Siemens Building Technology)
 - 4. Trane (by Damuth Trane)
 - 5. Mid-Atlantic
 - 6. ACES
- B. No additional control contractors will be considered.
- C. Pre-approved controls contractors shall also have completed two projects of similar scope to the HVAC Replacement at Menchville High 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.
- B. All equipment with on-board controller shall be Honeywell BACnet Strykers or BACnet MSTP compatible. Additionally, provide Niagara N4 Version 4.8.0.110 on all JACEs or Honeywell CIPer controllers.

2.2 DDC EQUIPMENT

3. Operator Work Station: This project will utilize existing workstations owned and maintained by NNPS.
3. Server: This project will utilize an existing server and software applications owned and maintained by NNPS.
3. 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.
- 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; RTUs, AHUS, VAV Terminal Boxes, 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

3. 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.
3. Fabricate panel's 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
 2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
 3. Power Supplies: Provide power supplies that have the line-voltage (120V) totally enclosed as to ensure Arch-Flash Compliance. Only low-voltage shall be exposed within any control panel.
 4. Provide ON/OFF power switch with over-current protection for control power sources to each local panel.

2.4 CONTROL CABLE

3. Network communication cable shall be plenum rated CAT5.

2.5 RACEWAYS AND CONDUITS

3. Raceways shall be provided for all surface-mounted control wiring.
3. If existing control wiring above ceilings is installed in conduits, all new control wiring above ceilings shall also be installed in conduits.
3. J hooks shall be utilized in running control wiring above ceilings and mechanically fastened to walls or hung from supports unless existing architectural or structural conditions do not allow for mechanical fastening.

2.6 CONTROL VALVES (PACKAGED AND UNITARY EQUIPMENT)

3. Valve housing shall consist of forged brass rated at no less than 360 psi at 250°F. Standard valve ball shall consist of chemical nickel-plated brass. Valve shall have a blow-out proof stem with two EPDM O-rings with minimum 600 psi rating. Valve stem assembly shall be of a pack-less design and be field-replaceable without removing the valve body from the piping. Manufacturer shall be able to provide glass-filled polymer ball insert to make flow control equal percentage. Valves shall be HONEYWELL "VBN" or equal.
3. 2-way valves shall have EPDM O-rings behind ball seals to allow for a minimum close-off pressure of 100 psi with actuator which provides 35lb-in. torque for ½ to 3 in. sizes. Valve shall be available with a minimum of 53 unique Cv values. Valve shall be available with threaded (FNPT) end connections.
3. 3-way valves shall be installed in a "T" configuration with actuator perpendicular to the shaft. Valve shall not require elbows of any kind. The 3-way valves shall have EPDM O-rings behind ball seals to allow for a minimum close-off pressure of 40 psi with an actuator that provides 35 lb-in. torque for ½ to 2-1/2 in. sizes. The 3-way valves must be available in both mixing and diverting configurations and shall be available with a minimum of 42 unique Cv values. Valve shall be available with threaded (FNPT) end connections.
3. Direct coupled actuator shall accept analog modulating (0-10Vdc) signal as indicated in the control sequences. Actuators shall be HONEYWELL "MN7507" or equal. Actuators shall provide minimum torque required for full valve shutoff position. Wiring terminals shall be provided for installation to control signal and power wiring. Actuators shall be provided with identification tags indelibly marked with Cv, model number, and tag location.

2.7 CONTROL DAMPERS

3. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:

1. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
 2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
 3. Damper shaft bearings shall be as recommended by manufacturer for application.
 4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 4 CFM per square foot at 1.0" w.c. differential pressure.
 5. All leakage testing and pressure ratings will be based on AMCA Standard 511.
 6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.
3. Control dampers shall be parallel or opposed blade types.

2.8 ELECTRIC DAMPER AND VALVE ACTUATORS

3. 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.
3. Spring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
3. 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 140°F.
10. Run Time: 200 seconds open, 40 seconds closed.
11. All actuators shall have a 5-year warranty.
12. Automatic Control Valves for Large Hydronic Equipment (Boilers, Pumps, etc.):
 - a. Provide BRAY SERIES 30/31 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.

2.9 FIRE PROTECTION DEVICES

- A. Smoke detectors shall be furnished by division 28 and installed by the mechanical contractor. Smoke detectors shall be wired to the fire alarm control panel by division 28. Provide interlock wiring to disable supply fan upon a detection of smoke.
- B. Power wiring to the smoke detector and signal wiring from the smoke detector to the fire alarm control panel shall be furnished under division 28. Unit shutdown wiring and control shall be the responsibility of the automatic temperature controls contractor.

2.10 SENSORS

3. Electronic Temperature Sensors: Vibration and corrosion resistant for wall, immersion, or duct mounting as required.
 1. Temperature sensors shall be platinum Resistance Temperature Device (RTD) or 10,000 ohm Thermistor.
 2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 2 feet in length.
 3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
 4. Space sensors shall be equipped with software limited set-point adjustment +/- 3 degrees), override switch, and communication port.
 5. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.2°F.
 6. Space sensor guards unless noted otherwise, provide lockable cast aluminum guards for sensors located in the gymnasium, and cafeteria. Provide lockable clear plastic guards in all public areas.
 7. Low-Voltage Space Thermostats shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed set point adjustment, 55°F-85°F set point range, 2°F maximum differential, and vented cover
 8. Line-Voltage Space Thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid state type, with heat anticipator, UL listing for electrical rating, concealed set point adjustment, 55°F-85°F set point range, 2°F maximum differential, and vented cover.
 9. Low-Limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 20 ft long. Element shall sense temperature in each 1 ft section and shall respond to lowest sensed temperature. Low limit thermostat shall be manual reset only.

3. Humidity Sensors: Bulk polymer sensor element

1. Duct and room sensors shall have a sensing range of 0% to 100% with accuracy of $\pm 3\%$ R.H.
2. Duct sensors shall be provided with a sampling chamber. Sensors shall be provided with element guard and mounting plate.
3. Outdoor air humidity sensors shall have a sensing range of 0% to 100% R.H. It shall be suitable for ambient conditions of -20 F to 140°F. Sensors shall be provided with element guard and mounting plate.
4. Humidity sensor's drift shall not exceed 1% of full scale per year.
5. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
6. Space sensor guards: Unless noted otherwise, provide lockable cast aluminum guards for sensors located in the gymnasium, and cafeteria. Provide lockable clear plastic guards in all public areas.

3. Carbon Dioxide (CO₂) Sensors:

1. Response time: 1 min.
2. Operation: Non-dispersive infrared (NDIR)
3. Sampling: Diffusion
4. Range: 0 to 2000 ppm
5. Accuracy: $\pm (30 \text{ ppm} + 2\% \text{ of reading})$
6. Analog Output: 0-10 Vdc (Default: 2-10 Vdc, 500 to 1500 ppm)
7. Relay: Normally open SPST (Default, close at 800 ppm)
8. Space sensor guards: Unless noted otherwise, provide lockable cast aluminum guards for sensors located in the gymnasium, and cafeteria. Provide lockable clear plastic guards in all public areas.

3. Differential Pressure Sensors:

1. Differential pressure switches shall be furnished as indicated for status purposes in air applications. Provide single pole single throw switch with fully adjustable differential pressure settings.
2. Differential pressure transmitters shall be furnished as indicated for hydronic system control. Provide direct acting transmitters, with range suitable for system and proportional output 4 to 20 mA.

3. 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.

F. Static Pressure Sensors

1. Sensor shall have linear output signal. Zero and span shall be field adjustable.

2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.

G. Relays

1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

H. Transformers and Power Supplies:

1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
3. Unit shall operate between 0 C and 50 C.
4. Unit shall be UL recognized.

3. Current Switches:

3. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

J. Pressure Transducers:

1. Transducer shall have linear output signal. Zero and span shall be field adjustable.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.

PART 3 – EXECUTION

3.1 EXAMINATION

3. 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.
3. 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.
3. 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

3. 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.
3. 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

16 of this Specification. Where the requirements of this Section differ from those in Division 16, 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 16 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 16 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 lightning 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 nameplates. Nameplates shall also include “Menchville High School, NNPS”.
- 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 online 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 perform an audit comparison to confirm that all existing points have been integrated into the new Building Controller including but not limited to physical inputs and outputs, setpoints, alarm points, and virtual points. Controls contractor shall confirm that any and all slaved points residing on DDC controllers have been recreated in the new Building Controller.
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. The controls contractor shall develop new user interface graphics for dynamic floor plans, dynamic HVAC unit schematics, dynamic central plant diagrams, lighting dashboard, HVAC dashboard, demand response dashboard, alarm console, zone schedules, and point trends.

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 Section 3.12 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 conduct a workstation only control point validation by searching for failed or erroneous values. Any and all failed or erroneous values shall be logged and reported to the Owner.
5. Demonstrate compliance with sequences of operation through all modes of operation.
6. 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 Architect. 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.
7. 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 8 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 EQUIPMENT COORDINATION.

- A. The Prime contractor shall conduct an HVAC Coordination meeting after submission of the HVAC equipment, fire alarm, and controls submittals to the Engineer, and prior to the return of the reviewed controls submittal to the Prime Contractor. The Prime Contractor shall coordinate the meeting time, date, and location with all parties, provide a written agenda, provide written meeting minutes, and provide a detailed issues summary (if unresolved issues remain open after the meeting).
- B. The Prime Contractor shall provide follow-up action as required with the following in mandatory attendance:
 1. Prime Contractor Project Manager and Project Superintendent
 2. Equipment manufacturer technical services representative (not a sales representative)
 3. Controls contractor technical services representative (not a sales representative)
 4. Mechanical engineer
 5. Owner's representative
 6. Fire alarm system representative
- C. The purpose of this meeting is to review equipment, control sequences, and the selected manufacturer's available control points. Upon completion of this meeting, the General Contractor shall be required to submit a meeting report detailing all discussed issues and

HVAC REPLACEMENT
MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA

coordinated solutions. Any unresolved issues shall require another mandatory meeting to ensure all items have been considered and coordinated prior to construction.

END OF SECTION 230900

APPENDIX A

EXISTING CONTROLS RECORD DRAWINGS

C

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CONTROLS INC.

Systems and Services Division

PROJECT: HVAC UPGRADES
MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA

RECEIVED BY: _____
DATE: _____

DWG. INDEX	DWG. DESCRIPTION	DWG. DATE
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D-2	JACE 2 RISER DIAGRAM	08/30/07
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D-4	ROOF TOP UNIT 1 SEQUENCE OF OPERATION	08/30/07
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D-16	AIR HANDLING UNIT 7 SEQUENCE OF OPERATION	08/30/07
D-17	ROOF TOP UNIT 8 DIAGRAM	08/30/07
D-18	ROOF TOP UNIT 8 SEQUENCE OF OPERATION	08/30/07
D-19	ROOF TOP UNIT 9 DIAGRAM	08/30/07
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D-21	ROOF TOP UNIT 10 DIAGRAM	08/30/07
D-22	ROOF TOP UNIT 10 SEQUENCE OF OPERATION	08/30/07
D-23	ROOF TOP UNIT 11 DIAGRAM	08/30/07
D-24	ROOF TOP UNIT 11 SEQUENCE OF OPERATION	08/30/07
D-25	ROOF TOP UNIT 12 DIAGRAM	08/30/07
D-26	ROOF TOP UNIT 12 SEQUENCE OF OPERATION	08/30/07

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D-32	ROOF TOP UNIT 15 SEQUENCE OF OPERATION	08/30/07
D-33	ROOF TOP UNIT 16 DIAGRAM	08/30/07
D-34	ROOF TOP UNIT 16 SEQUENCE OF OPERATION	08/30/07
D-35	ROOF TOP UNIT 17 DIAGRAM	08/30/07
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		08/30/07

C

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CONTROLS INC.

Systems and Services Division

- ☐ Environmental Control System
- ☒ Building Automation System
- ☐ Fire Management System
- ☐ Security System
- ☐ Lighting Services
- ☐ Telecommunication System
- ☐ Integrated Motor Control Center
- ☐ Air and Water Systems Balancing
- ☐ Instrumentation System Installation
- ☐ Building Operations Management
- ☐ Energy Conservation Control
- ☐ Custom Programmed Maintenance

Automatic Temperature Controls
Heating
Air Conditioning
Air Filters
Water Treatment
Coil Cleaning
Control Center
Fire Management
Security Management
Sound and Communication
Programmed Clocks
Contract Operations
Time-Shared Automated Building Service
Refrigeration
Electrical Equipment
Emergency Generator / Lighting Equipment
Industrial Controls / Recording / Indication Equipment

PROJECT

HVAC UPGRADES
MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VA.

ARCHITECT

-

ENGINEER

THOMPSON CONSULTING ENGINEERS
9308 WARWICK BLVD
NEWPORT NEWS, VA 23601

USER DEFINED

-

CONTRACTOR

D.E. KIRBY INC.
-3921 GARWOOD AVENUE
PORTSMOUTH, VA 23701

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

C

HESAPEAKE

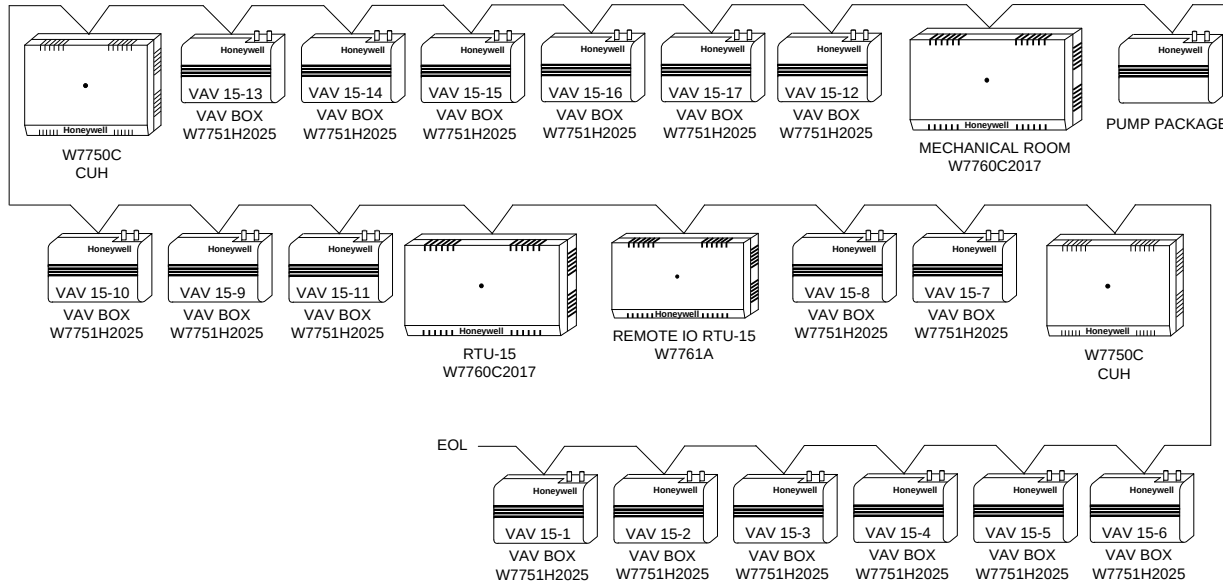
CONTROLS INC.

Systems and Services Division

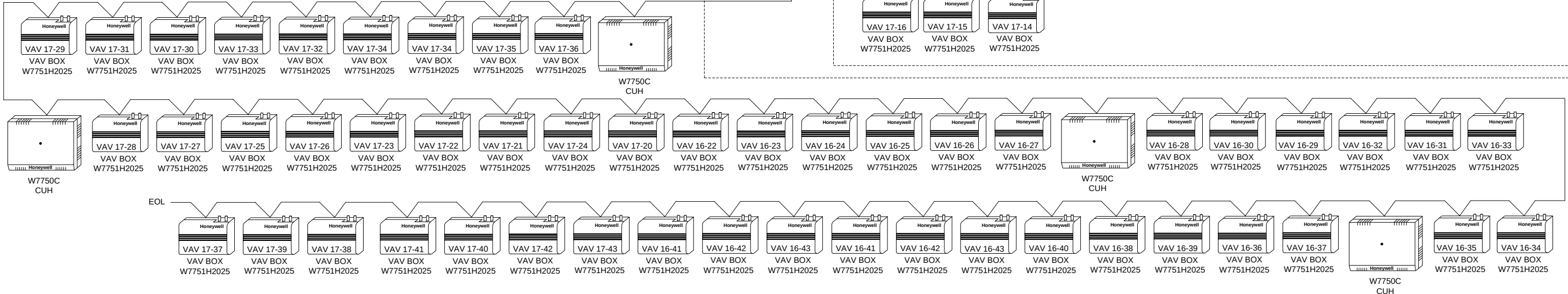
Branch Information
1220 Executive Blvd., Suite 108
Chesapeake, VA 23320
www.chesapeakecontrols.com
ph: (757)-547-9738
fx: (757)-547-2781

SALES REPRESENTATIVE	PROJECT MANAGER	SYSTEMS ENGINEER	DATE	CONTRACT NUMBER
RE	JP	JP	11/05/14	0830-0134

JACE #1 COMMUNICATION RISER



G WING



J & K WINGS (2nd Floor)



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Drawing Tip

1ACE-1 RISE

Project Title

**HVAC UPGRADES
MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA**

C HESAPEAKE
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PROJECT NUMBER

0830-0134

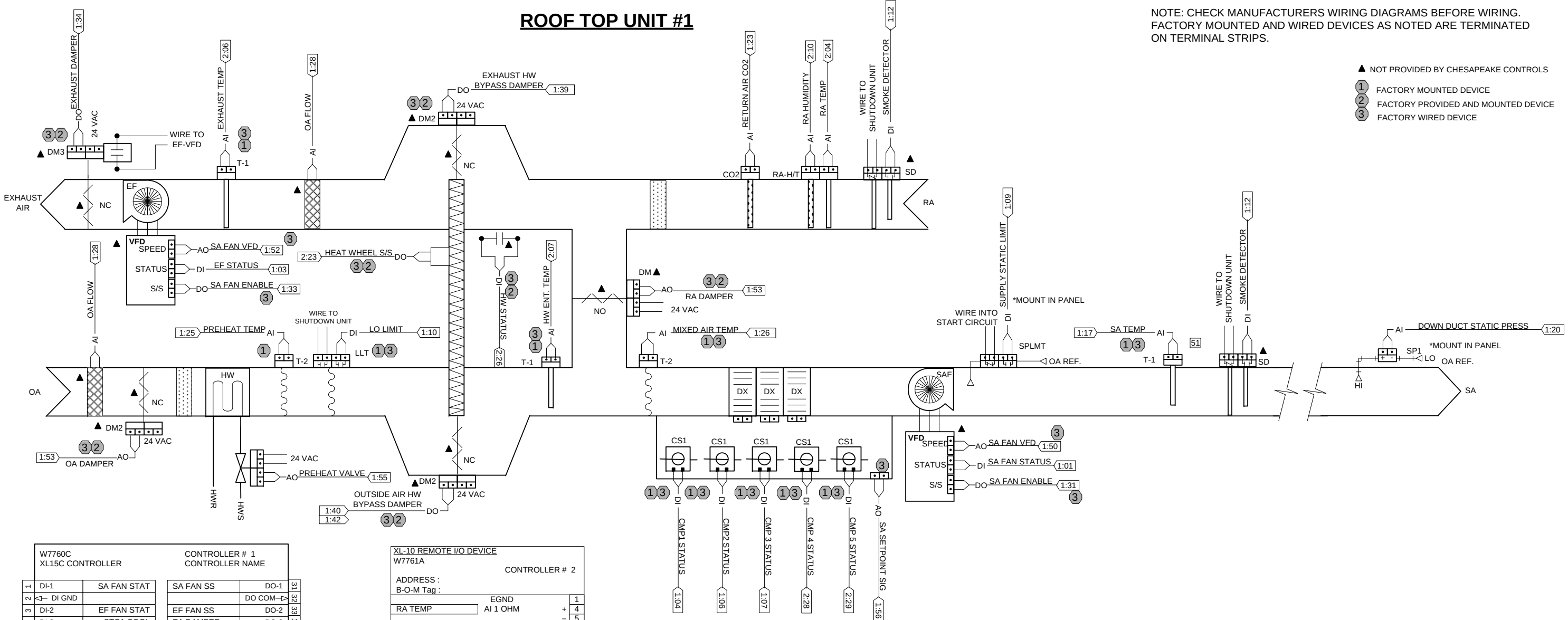
WING NUMBER

D-1

ROOF TOP UNIT #1

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

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 - 2 FACTORY PROVIDED AND MOUNTED DEVICE
 - 3 FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI-1	SA FAN STAT	32
3	DI-2	EF FAN STAT	33
4	DI-3	STG1 COOL	34
5	DI-3	STG1 COOL	35
6	DI-4	STG2 COOL	36
7	DI-5	STG3 COOL	37
8	DI-5	STG3 COOL	38
9	DI-6	HI STATIC LMT	39
10	DI-7	LOW LIMIT	40
11	DI-8	SMOKE DET.	41
12	LON		42
13	LON		43
14	LON		44
15	LON		45
16	LON		46
17	AI-1	SA TEMP	47
18	AI-1	SA TEMP	48
19	AI-2		49
20	AI-3	DUCT STATIC	50
21	AI-4	EA AIR FLOW	51
22	AI-5	RETURN CO2	52
23	AI-6	PREHEAT TEM	53
24	AI-7	MA TEMP	54
25	AI-8	AIR FLOW	55
26	AI-8	AIR FLOW	56
27	AI-8	AIR FLOW	57
28	AI-8	AIR FLOW	58
29	AI-8	AIR FLOW	59
30	AI-8	AIR FLOW	60

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :		B-O-M Tag :	
RA TEMP	AI 1 OHM	1	4
EXHAUST TEMP	AI 2 OHM	5	6
HW ENT TEMP	AI 3 OHM	7	8
	AI 4 OHM	9	10
RA HUMIDITY	AI 5 V/mA	11	12
	AI 6 V/mA	13	14
	22 VDC OUT	15	16
	E-BUS (FTT)	17	18
	E-BUS (FTT)	19	20
	TRIAC 8	21	22
	TRIAC 7	23	24
	TRIAC 6	25	26
	TRIAC 5	27	28
	TRIAC 4	29	30
	TRIAC 3	31	32
	TRIAC 2	33	34
	TRIAC 1	35	36
	COM	37	38
	24 VAC IN	39	40
HEAT WHEEL	DI 1	41	42
STG4 COOL	DI 2	43	44
STG5 COOL	DI 3	45	46
	DI 4	47	48

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-1 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3MSTM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
SP1	PRESSURE TRANSMITTER	VERIS	PXPLX02S	1
SPLMT	STATIC PRRESSURE HI LIMIT	DYNACON	AFS-460-DSS	1
CS1	RELAY	VERIS	H-600	5
LLT	FREEZESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

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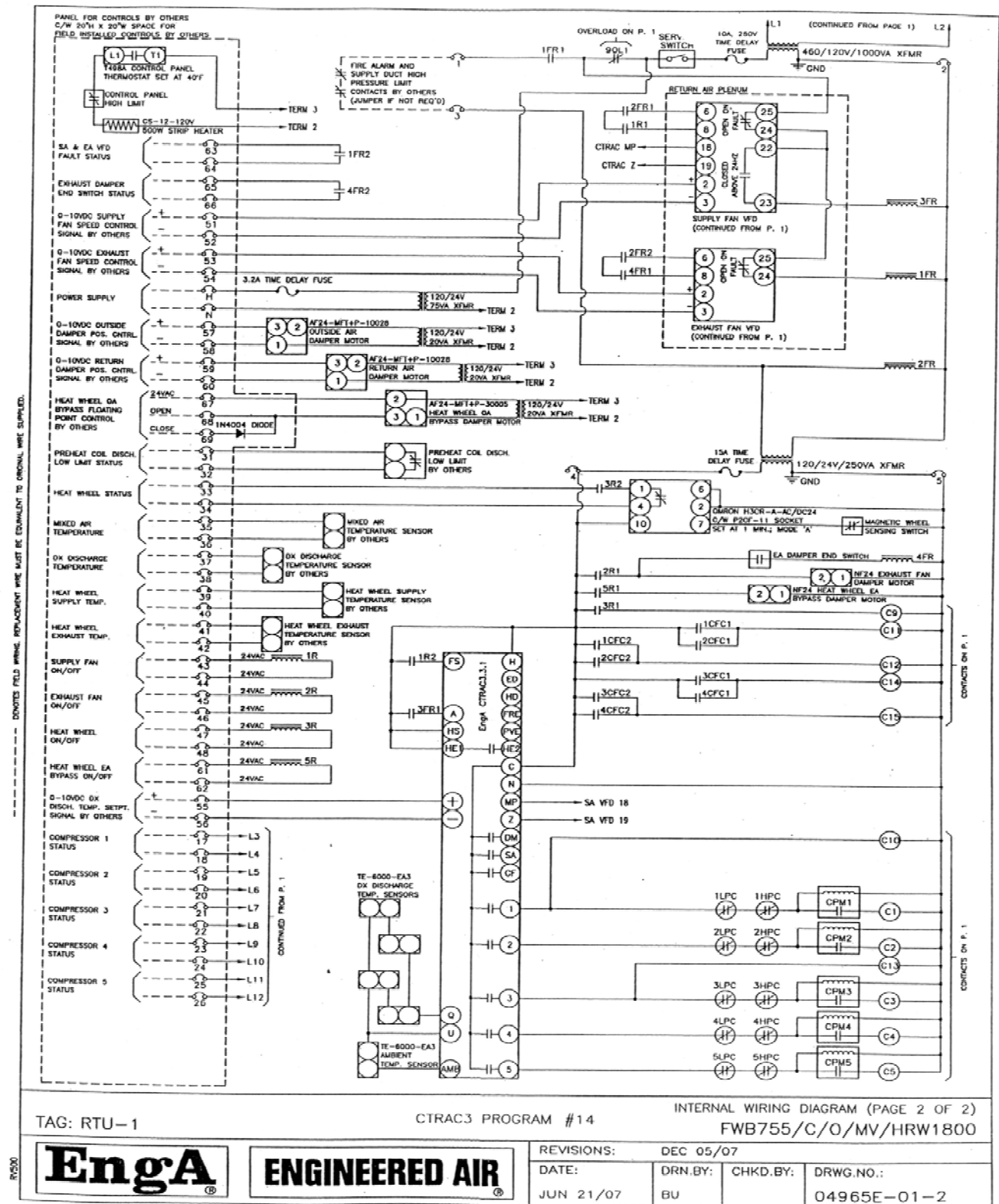
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Drawing Title		2		ENGINEERING CHANGES		1/18/08		JBP	
ROOF TOP UNIT 1 WIRING DIAGRAM		1		TERMINATION CHANGES		12/19/07		JBP	
REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE	
Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED	
MH		JM		JP		BY JP		DATE 06/08/07	
Project Title		Branch Information		CONTRACT NUMBER		DATE			
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134		D-3			
		CHESAPEAKE CONTROLS, INC.		Systems & Services Division					

ROOF TOP UNIT #1 SEQUENCE OF OPERATION

VARIABLE AIR VOLUME, HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#1, #10, #11, #15, #16, #17)
CONTROL (CLASSROOMS AND ADMINISTRATION/MEDIA CENTER)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air, exhaust, and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the energy recovery wheel will be disabled, and the supply fan will be enabled. Unit supply air temperature will be reset upward to 80°F (adjustable). Unit will change to "occupied mode" when return air temperature reaches 70°F (adjustable), or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan and the energy recovery wheel. The DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station closing the return air damper a proportional amount. The DDC Controller will open the exhaust air damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. Supply fan speed will be controlled to maintain down duct supply air static pressure setpoint. System will monitor the primary air valve position on all terminal variable air volume boxes and reset the supply duct static pressure setpoint so that at least one terminal VAV boxes primary air valve is at least 95% open. If the discharge static pressure rises above the static high-pressure setpoint, (4" wc adjustable) supply fan will be disabled. Manual reset will be required to restart unit.
- D. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- E. The air-conditioning unit has four modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain the discharge air temperature (50°F adjustable). The discharge air temperature will be reset from the space having the highest cooling demand.
 4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the mixed air temperature is below the discharge air temperature setpoint (50°F adjustable), the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper, and the Outside Air Recovery Bypass Damper will be closed. The preheat valve will modulate open to maintain discharge air temperature of 50°F (adjustable) setpoint of the DDC Controller.
- F. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge air temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F. If the temperature, measured downstream of the heat recovery wheel, rises above the unit discharge air temperature setpoint, then the Outside Air Recovery Bypass Damper shall modulate open to bypass the preheated air around the heat recovery wheel.
- G. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- H. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- I. Whenever the unit is de-energized, the DDC Controller will modulate the preheat valve to maintain 50°F as sensed by the preheat coil discharge sensor.
- J. The mechanical cooling will be locked out if the supply fan cfm falls below 40% of maximum. The fan rpm that results in this cfm value shall be determined during the unit fan balancing.



ROOF TOP UNIT #2

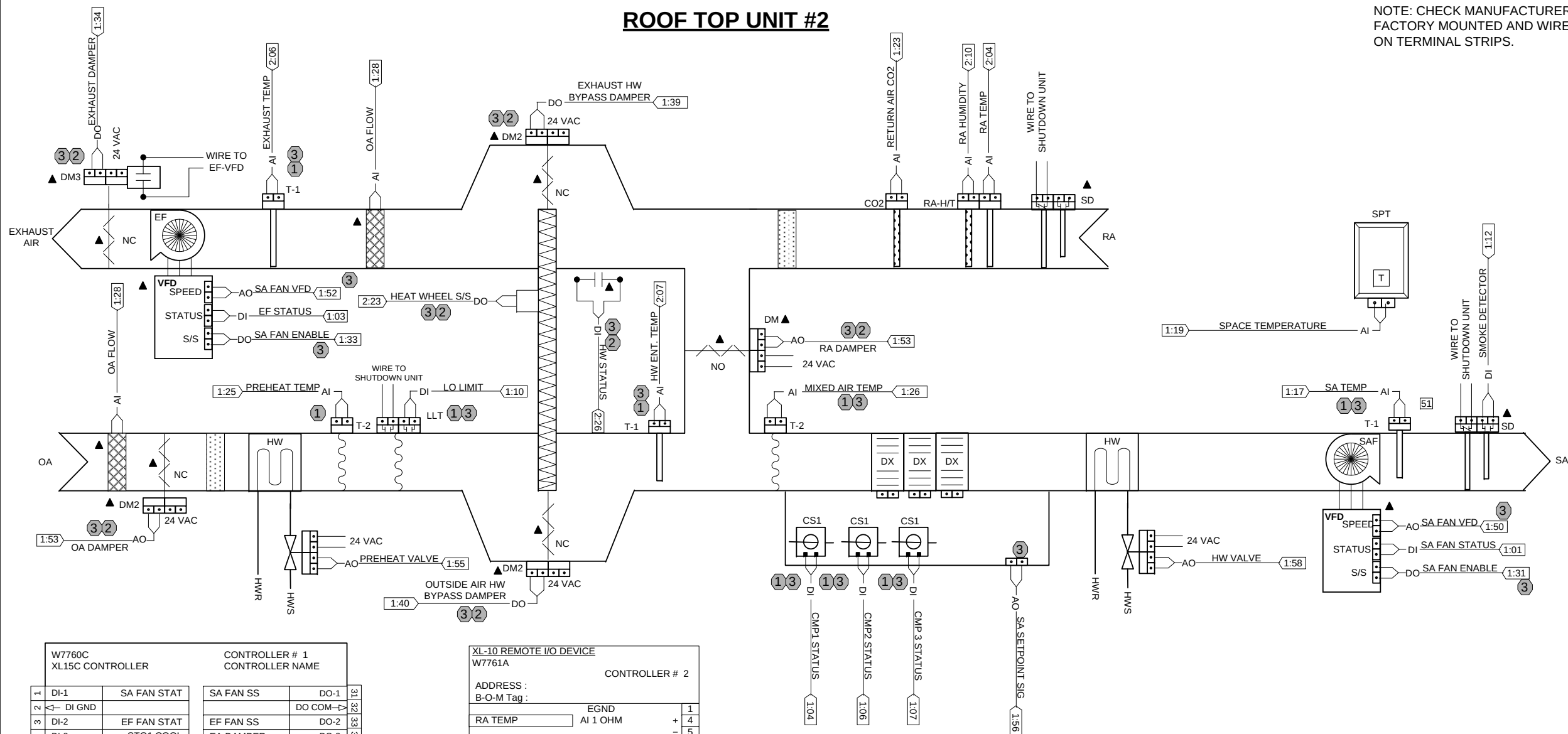
NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

▲ NOT PROVIDED BY CHESAPEAKE CONTROLS

1 FACTORY MOUNTED DEVICE

2 FACTORY PROVIDED AND MOUNTED DEVICE

3 FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	SA FAN SS
2	DI-2	SA FAN STAT	DO-1
3	DI-3	EF FAN STAT	DO COM
4	DI-3	STG1 COOL	DO-2
5	DI-4	STG1 COOL	DO-3
6	DI-5	STG2 COOL	DO COM
7	DI-5	STG2 COOL	DO-4
8	DI-6	STG2 COOL	DO-5
9	DI-7	LOW LIMIT	DO COM
10	DI-8	SMOKE DET.	EA BYPASS
11	DI-8	SMOKE DET.	OA BYPASS
12	DI-8	SMOKE DET.	DO-8
13	DI-8	SMOKE DET.	DO-8
14	DI-8	SMOKE DET.	DO-8
15	DI-8	SMOKE DET.	DO-8
16	DI-8	SMOKE DET.	DO-8
17	DI-8	SMOKE DET.	DO-8
18	DI-8	SMOKE DET.	DO-8
19	DI-8	SMOKE DET.	DO-8
20	DI-8	SMOKE DET.	DO-8
21	DI-8	SMOKE DET.	DO-8
22	DI-8	SMOKE DET.	DO-8
23	DI-8	SMOKE DET.	DO-8
24	DI-8	SMOKE DET.	DO-8
25	DI-8	SMOKE DET.	DO-8
26	DI-8	SMOKE DET.	DO-8
27	DI-8	SMOKE DET.	DO-8
28	DI-8	SMOKE DET.	DO-8
29	DI-8	SMOKE DET.	DO-8
30	DI-8	SMOKE DET.	DO-8
31	DI-8	SMOKE DET.	DO-8
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36	DI-8	SMOKE DET.	DO-8
37	DI-8	SMOKE DET.	DO-8
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40	DI-8	SMOKE DET.	DO-8
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42	DI-8	SMOKE DET.	DO-8
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44	DI-8	SMOKE DET.	DO-8
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58	DI-8	SMOKE DET.	DO-8
59	DI-8	SMOKE DET.	DO-8
60	DI-8	SMOKE DET.	DO-8
61	DI-8	SMOKE DET.	DO-8
62	DI-8	SMOKE DET.	DO-8
63	DI-8	SMOKE DET.	DO-8
64	DI-8	SMOKE DET.	DO-8
65	DI-8	SMOKE DET.	DO-8
66	DI-8	SMOKE DET.	DO-8
67	DI-8	SMOKE DET.	DO-8
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69	DI-8	SMOKE DET.	DO-8
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72	DI-8	SMOKE DET.	DO-8
73	DI-8	SMOKE DET.	DO-8
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76	DI-8	SMOKE DET.	DO-8
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79	DI-8	SMOKE DET.	DO-8
80	DI-8	SMOKE DET.	DO-8
81	DI-8	SMOKE DET.	DO-8
82	DI-8	SMOKE DET.	DO-8
83	DI-8	SMOKE DET.	DO-8
84	DI-8	SMOKE DET.	DO-8
85	DI-8	SMOKE DET.	DO-8
86	DI-8	SMOKE DET.	DO-8
87	DI-8	SMOKE DET.	DO-8
88	DI-8	SMOKE DET.	DO-8
89	DI-8	SMOKE DET.	DO-8
90	DI-8	SMOKE DET.	DO-8
91	DI-8	SMOKE DET.	DO-8
92	DI-8	SMOKE DET.	DO-8
93	DI-8	SMOKE DET.	DO-8
94	DI-8	SMOKE DET.	DO-8

XL-10 REMOTE I/O DEVICE		CONTROLLER # 2	
W7761A			
ADDRESS :			
B-O-M Tag :			
	EGND		1
RA TEMP	AI 1 0HM	+	4
		-	5
EXHAUST TEMP	AI 2 0HM	+	6
HW ENT TEMP	AI 3 0HM	+	7
		-	8
	AI 4 0HM	+	9
RA HUMIDITY	AI 5 V/mA	+	10
		-	11
	AI 6 V/mA	+	12
	22 VDC OUT	+	13
	E-BUS (FTT)		14
	E-BUS (FTT)		15
	TRIAC 8	+	16
	TRIAC 7	+	17
	TRIAC 6	+	18
	TRIAC 5	+	19
	TRIAC 4	+	20
	TRIAC 3	+	21
	TRIAC 2	+	22
HEAT WHEEL S/S	TRIAC 1	+	23
	COM		24
	24 VAC IN		25
HEAT WHEEL	DI 1	+	26
		-	27
	DI 2	+	28
	DI 3	+	29
		-	30
	DI 4	+	31

**SEE NEXT PAGE FOR SEQUENCE OF OPERATION*

RTU-2 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	3
LLT	FREEZESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

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Drawing Title

ROOF TOP UNIT 2 WIRING DIAGRAM

Project Title

**MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA**

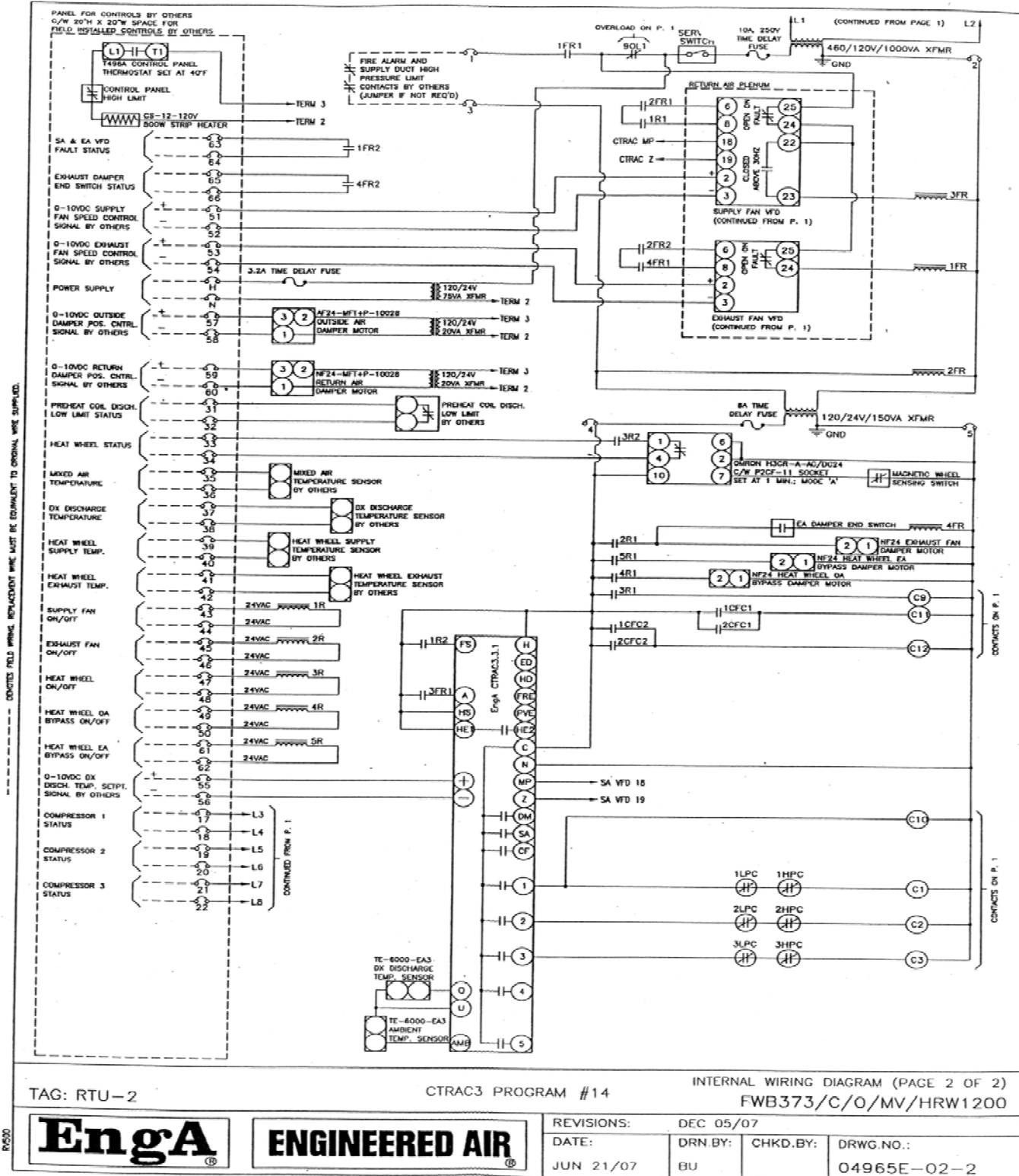
		2	ENGINEERING CHANGES						1/18/08	JBP
		1	TERMINATION CHANGES						12/19/07	JBP
REFERENCE DRAWING		NO.		REVISION-LOCATION				ECN	DATE	BY
Sales Engineer MH	Project Manager JM	Application Engineer JP		DRAWN BY JP DATE 06/08/07				APPROVED BY DATE		

 CHESAPEAKE CONTROLS, INC. Systems & Services Division	Branch Information 1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781	CONTRACT NUMBER 0830-0134
		DRAWING NUMBER D-5

ROOF TOP UNIT #2 SEQUENCE OF OPERATION

4.2 CONSTANT VOLUME HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#2, #12, #13, #14)
(AUDITORIUM AND CAFETERIA)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air exhaust and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the hot water reheat valve will be fully open to the coil, the energy recovery wheel will be disabled, and the supply fan will be enabled to full speed. Unit will change to "occupied mode" when return air reaches 70°F (adjustable) or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan variable frequency drive and the energy recovery wheel. The variable frequency drive will index the supply fan to 100% of maximum cfm. The DDC Controller will modulate the Outside Air Damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station, closing the Return Air Damper a proportional amount. The DDC Controller will open the Exhaust Air Damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- D. The air-conditioning unit has four modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain space temperature at the setpoint of the DDC Controller.
 4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Outdoor Air Recovery Bypass Damper will be closed, the Exhaust Air Recovery Bypass Damper will be closed. The hot water valve will modulate open to maintain space temperature at the setpoint of the DDC Controller.
- E. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F.
- F. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the air-cooled condensing unit section and start the compressors. The supply fan VFD will maintain the fan at the 50% setting during dehumidification. Should the dehumidification process cause the space to over cool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- G. On a rise in space Carbon Dioxide to the setpoint of the DDC Controller, the DDC Controller will modulate the outside air damper between its minimum and maximum CO₂ damper position setpoints to maintain CO₂ setpoint.
- H. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- I. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- J. Whenever the unit is de-energized, the DDC Controller will modulate the preheat and reheat valves to maintain 55°F as sensed by the coil discharge sensors.

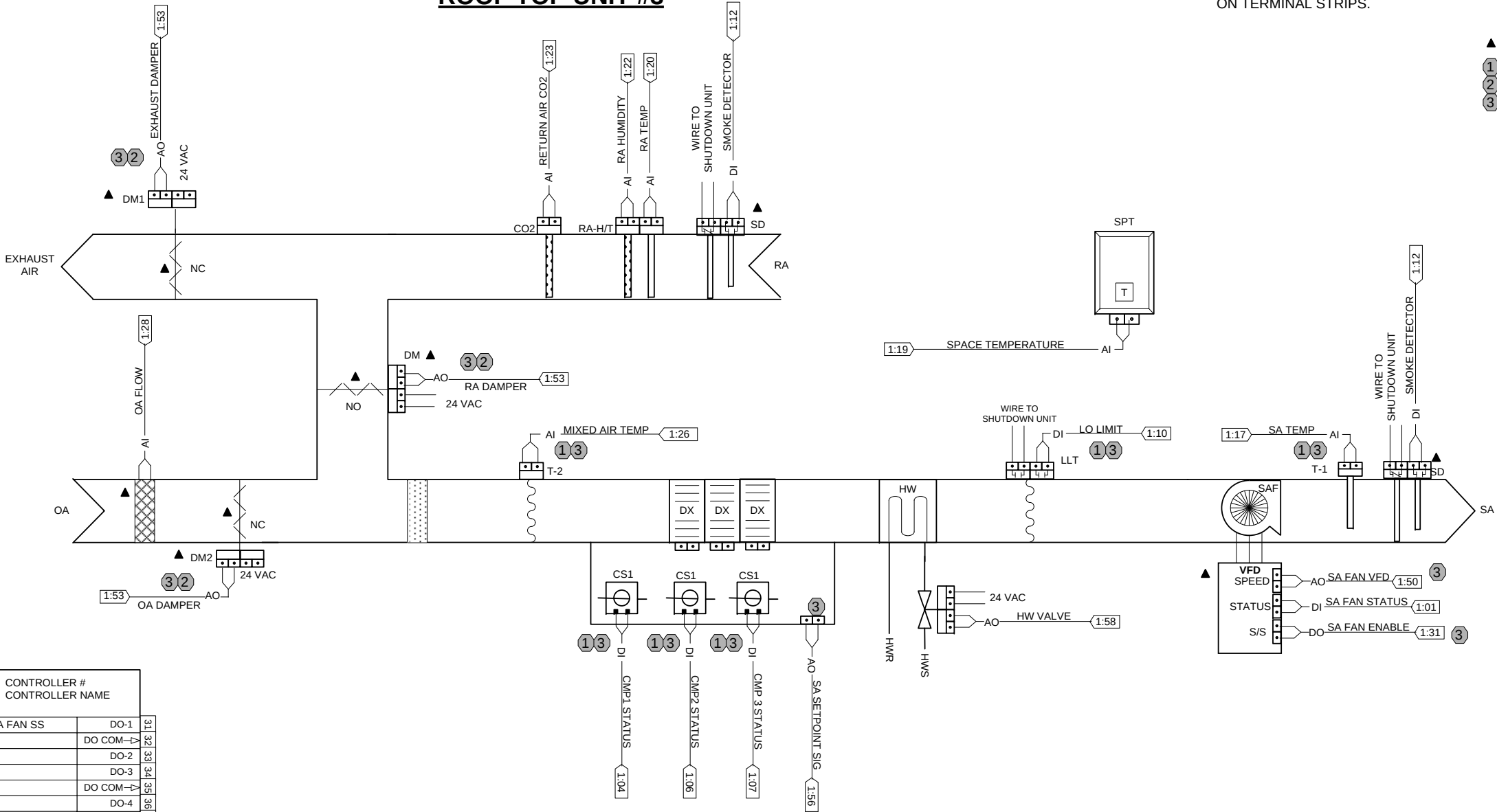


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	ROOF TOP UNIT 2 SEQUENCE OF OPERATION									
				1	TERMINATION CHANGES		12/19/07	JBP		
			REFERENCE DRAWING		NO.	REVISION-LOCATION		ECN	DATE	BY
	Sales Engineer MH		Project Manager JM	Application Engineer JP		DRAWN BY JP DATE 06/08/07		APPROVED BY DATE		
	Project Title	MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA			CHESAPEAKE CONTROLS, INC. Systems & Services Division			Branch Information 1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		CONTRACT NUMBER 0830-0134 DRAWING NUMBER D-6

ROOF TOP UNIT #3

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- ① FACTORY MOUNTED DEVICE
② FACTORY PROVIDED AND MOUNTED DEVICE
③ FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI-1 GND	DO COM	32
3	DI-2		33
4	DI-3	STG1 COOL	34
5	DI-3 GND	DO COM	35
6	DI-4	STG2 COOL	36
7	DI-5	STG3 COOL	37
8	DI-5 GND	DO COM	38
9	DI-6		39
10	DI-7	LOW LIMIT	40
11	DI-7 GND	DO COM	41
12	DI-8	SMOKE DET.	42
13	LON		43
14	LON		44
15	LON		45
16	LON		46
17	AI-1	SA TEMP	47
18	AI-1 GND		48
19	AI-2	SPACE TEMP	49
20	AI-3	RA TEMP	50
21	AI-3 GND		51
22	AI-4	RA HUMID	52
23	AI-5	RETURN CO2	53
24	AI-5 GND		54
25	AI-6		55
26	AI-7	MA TEMP	56
27	AI-7 GND		57
28	AI-8	AIR FLOW	58
29	GND		59
30	GND		60

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-3 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	1
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	1
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-HT	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	3
LLT	FREEZE/STAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

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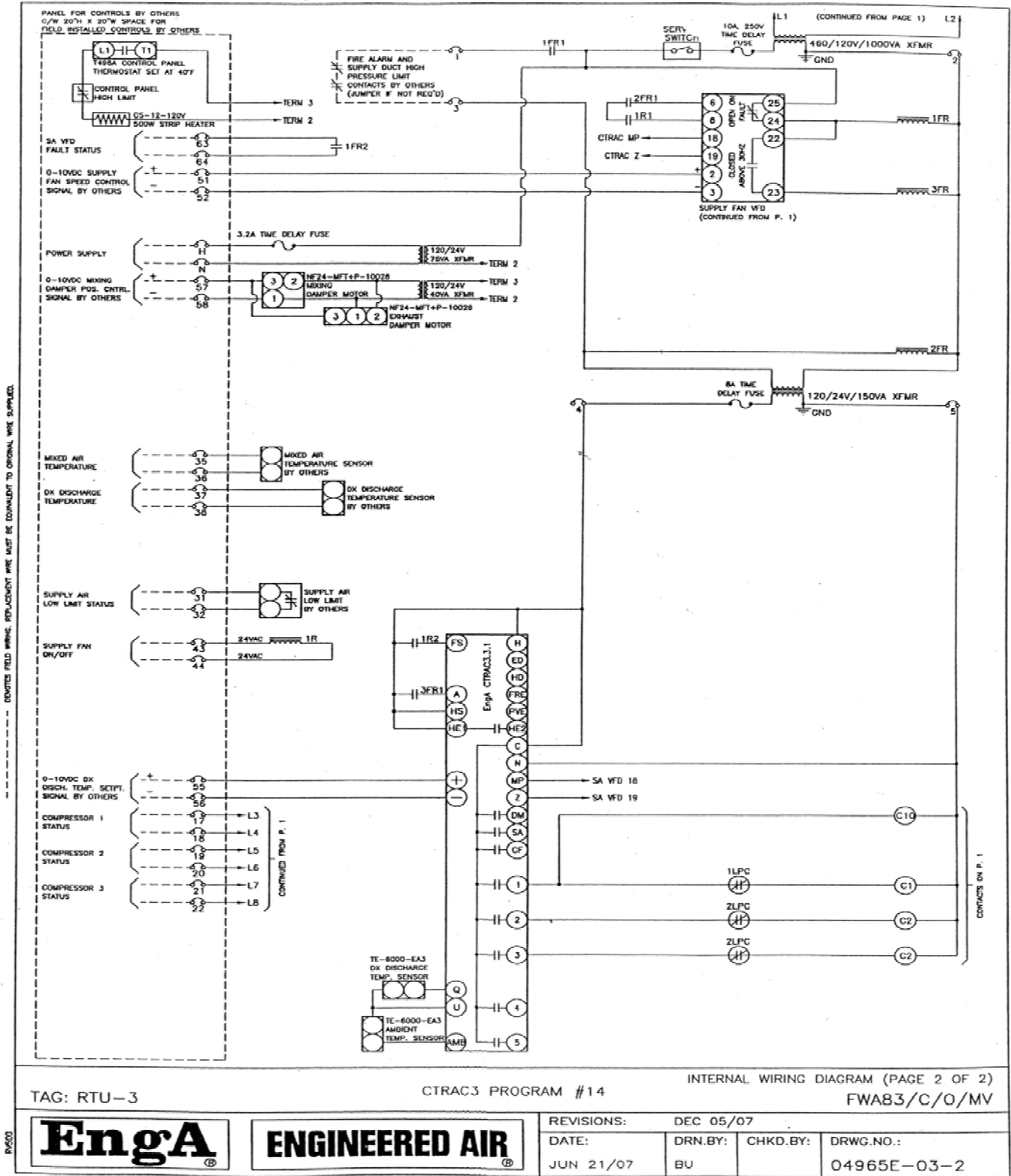
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Drawing Title									
ROOF TOP UNIT 3 WIRING DIAGRAM				2		TERMINATION CHANGES		04/07/08	
				1		TERMINATION CHANGES		12/19/07	
		REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN	
Project Title		MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		Sales Engineer MH		Project Manager JM		Application Engineer JP	
				BY JP		DATE 06/08/07		APPROVED	
								CONTRACT NUMBER	
								1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781	
								0830-0134	
								DRAWING NUMBER	
								D-7	

ROOF TOP UNIT #3 SEQUENCE OF OPERATION

4.3 CONSTANT VOLUME ROOFTOP AIR-CONDITIONING UNIT (#3) CONTROL (EXERCISE ROOM)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air damper will remain fully closed, the return air damper will be fully open, and the hot water reheat valve will be fully open to the coil. The return air sensor will switch to "occupied mode" at 70°F (adjustable) or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station closing the return air damper a proportional amount and open the associated relief damper. The DDC Controller will signal the supply fan VFD to run the supply fan at 100% of the maximum cfm.
- C. On a rise in space temperature to the heating setpoint of the DDC Controller, the DDC Controller will modulate the hot water heating valve closed to the coil. On a further rise in space temperature, the DDC Controller will modulate the outside air damper open, closing the return air damper a proportional amount for free cooling. Whenever the setting of the mixed air temperature low limit is reached, the DDC Controller will modulate the outside air damper closed to its preset minimum position, closing the return air damper a proportional amount. Whenever the outside air temperature rises above the setpoint of the DDC Controller, the DDC Controller will disable the economizer cycle. On a further rise in space temperature, the DDC Controller will energize the air-cooled condensing unit section and cycle the compressors to maintain space temperature. On a fall in space temperature, the reverse sequence will occur.
- D. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the remote air-cooled condensing unit section and start the compressors. The supply fan VFD will reduce the fan speed to the 50% cfm setting during dehumidification, and discharge temperature will be reset to 50°F. Should the dehumidification process cause the space to overcool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- E. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan and close the outside air damper.
- F. On detection of products of combustion, the smoke detector will stop the unit supply air fan and close the outside air damper.
- G. Whenever the unit is de-energized, the DDC Controller will modulate the reheat valve to maintain 55°F as sensed by the supply air sensor.

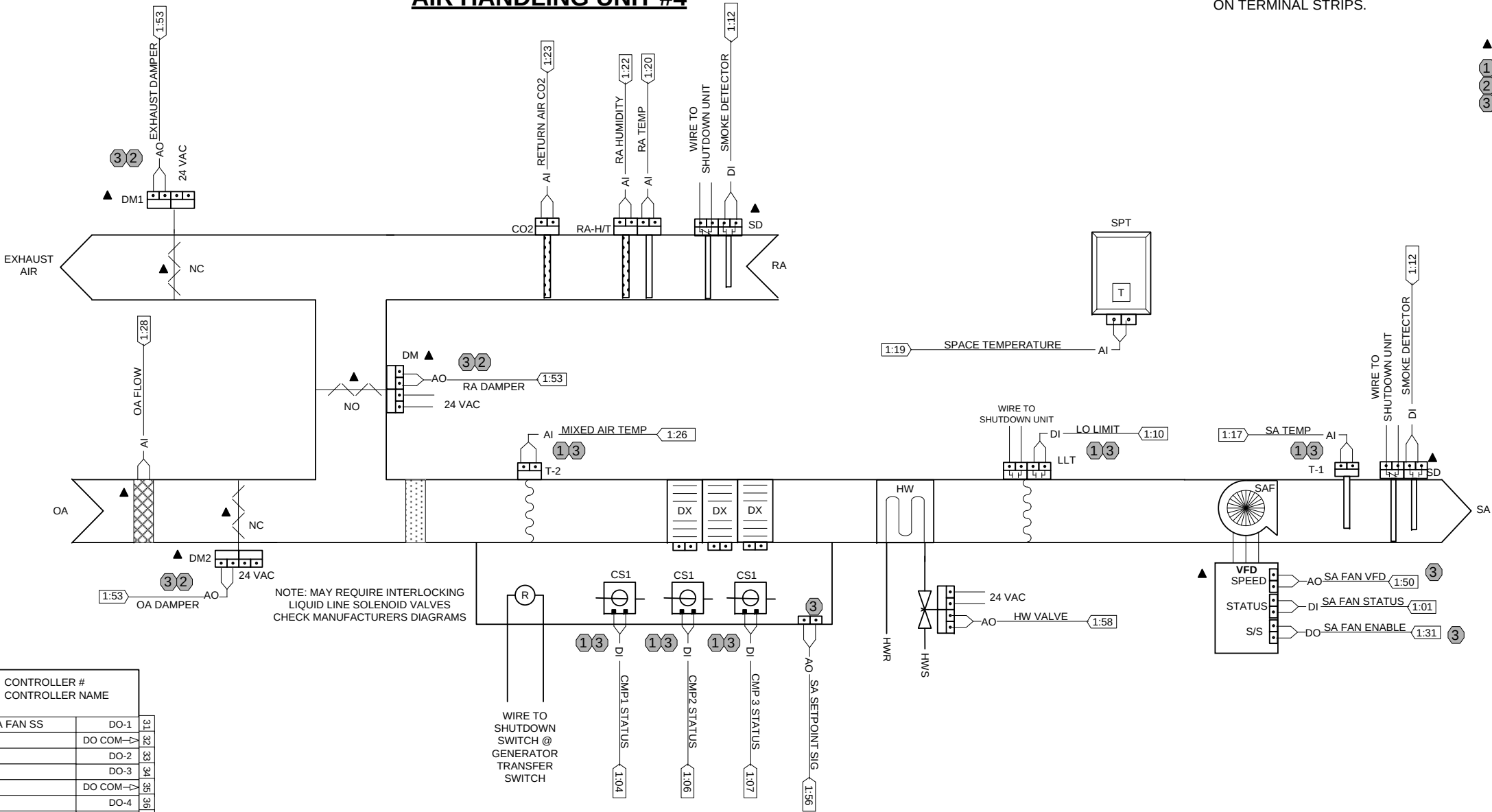


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		Project Title		MENHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		Branch Information		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781	
		Drawing Number		D-8		Contract Number		0830-0134	
		Drawing Title		ROOF TOP UNIT 3 SEQUENCE OF OPERATION		Revision Location		ECN	
		Sales Engineer		Project Manager		Application Engineer		DATE	
		MH		JM		JP		06/08/07	

AIR HANDLING UNIT #4

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- ① FACTORY MOUNTED DEVICE
② FACTORY PROVIDED AND MOUNTED DEVICE
③ FACTORY WIRED DEVICE



NOTE: MAY REQUIRE INTERLOCKING
LIQUID LINE SOLENOID VALVES
CHECK MANUFACTURERS DIAGRAMS

W7760C XL15C CONTROLLER		CONTROLLER # CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI-2	STG1 COOL	32
3	DI-3	STG2 COOL	33
4	DI-4	STG3 COOL	34
5	DI-5	LOW LIMIT	35
6	DI-6	SMOKE DET.	36
7	DI-7		37
8	DI-8		38
9	LON		39
10	LON		40
11	LON		41
12	LON		42
13	LON		43
14	LON		44
15	LON		45
16	LON		46
17	AI-1	SA TEMP	47
18	AI-2	SPACE TEMP	48
19	AI-3	RA TEMP	49
20	AI-4	RA HUMID	50
21	AI-5	RETURN CO2	51
22	AI-6	MA TEMP	52
23	AI-7	AIR FLOW	53
24	AI-8		54
25	GND		55
26	GND		56
27	GND		57
28	GND		58
29	GND		59
30	GND		60

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-4 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	1
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	1
SPT	SPACE TEM P SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	3
LLT	FREEZESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

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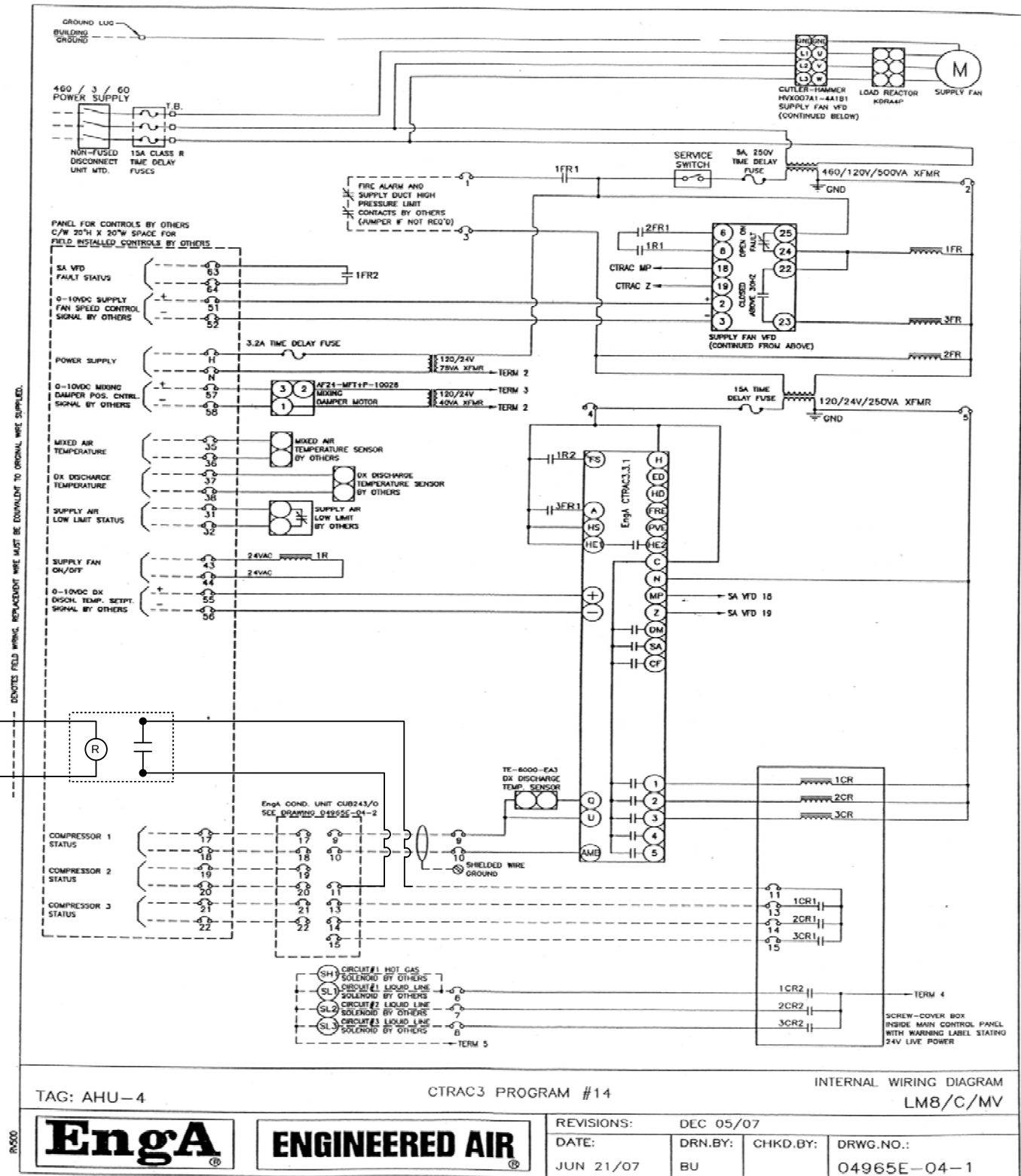
Drawing Title		1	GENERATOR INTERLOCK	1/02/09	JBP
ROOF TOP UNIT 4 WIRING DIAGRAM		2	TERMINATION CHANGES	04/07/08	JBP
Project Title		1	TERMINATION CHANGES	12/19/07	JBP
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		REFERENCE DRAWING			
		NO.			
		REVISION-LOCATION			
		ECN			
		DATE			
		BY			
		DATE			
		DRAWN			
		DATE			
		APPROVED			
		DATE			
		Branch Information			
		1220 Executive Blvd			
		Suite 108			
		Chesapeake, VA			
		23320			
		(ph) 757-547-9738			
		(fax) 757-547-2781			
		CONTRACT NUMBER			
		0830-0134			
		DRAWING NUMBER			
		D-9			

AIR HANDLING UNIT #4 SEQUENCE OF OPERATION

4.4 CONSTANT VOLUME INDOOR AIR-HANDLING UNIT (#4 and #7) CONTROL (GYMNASIUMS)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air damper will remain fully closed, the return air damper will be fully open, and the hot water reheat valve will be fully open to the coil. The return air sensor will switch to "occupied mode" at 70°F (adjustable) or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station, closing the return air damper a proportional amount and opening the associated relief damper. The DDC Controller will signal the supply fan VFD to run the supply fan at 100% of the maximum cfm.
- C. On a rise in space temperature to the heating setpoint of the DDC Controller, the DDC Controller will modulate the hot water heating valve closed to the coil. On a further rise in space temperature, the DDC Controller will modulate the outside air damper open, closing the return air damper a proportional amount for free cooling. Whenever the setting of the mixed air temperature low limit is reached, the DDC Controller will modulate the outside air damper closed to its preset minimum position, closing the return air damper a proportional amount. Whenever the outside air temperature rises above the setpoint of the DDC Controller, the DDC Controller will disable the economizer cycle. On a further rise in space temperature, the DDC Controller will energize the remote air-cooled condensing unit section and cycle the compressors to maintain space temperature. On a fall in space temperature, the reverse sequence will occur.
- D. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the remote air-cooled condensing unit section and start the compressors. The supply fan VFD will reduce the fan speed to the 50% setting during dehumidification, and discharge temperature will be reset to 50°F. Should the dehumidification process cause the space to overcool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- E. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- F. On detection of products of combustion, the smoke detector will stop the unit supply air fan and close the outside air damper.
- G. Whenever the unit is de-energized, the DDC Controller will modulate the reheat valve to maintain 55°F as sensed by the supply air sensor.

WIRE TO SHUTDOWN SWITCH @ GENERATOR TRANSFER SWITCH

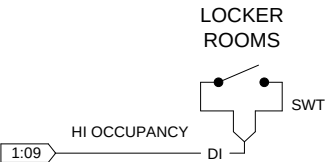
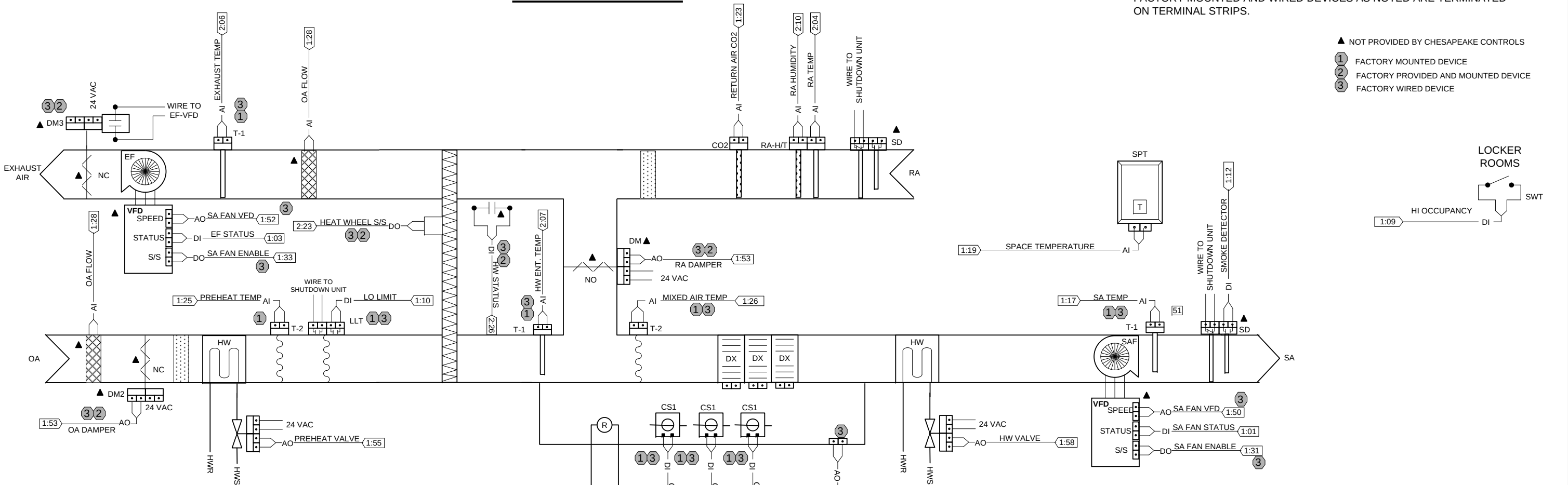


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	ROOF TOP UNIT 4 SEQUENCE OF OPERATION			1	GENERATOR INTERLOCK				1/02/09	JBP	
				1	TERMINATION CHANGES				12/19/07	JBP	
			REFERENCE DRAWING		NO.	REVISION-LOCATION		ECN	DATE	BY	
	Project Title		Sales Engineer MH	Project Manager JM	Application Engineer JP	DRAWN BY JP DATE 06/08/07		APPROVED BY DATE		CONTRACT NUMBER	
	MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC. Systems & Services Division			Branch Information 1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134			
								DRAWING NUMBER D-10			

ROOF TOP UNIT #5

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED ON TERMINAL STRIPS.

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- ① FACTORY MOUNTED DEVICE
② FACTORY PROVIDED AND MOUNTED DEVICE
③ FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER				CONTROLLER # 1 CONTROLLER NAME			
1	DI-1	SA FAN STAT		SA FAN SS	DO-1	31	
2	DI-2	EF FAN STAT		EF FAN SS	DO-2	33	
3	DI-3	STG1 COOL		EA DAMPER	DO-3	34	
4	DI-4	STG2 COOL			DO-4	36	
5	DI-5	STG3 COOL			DO-5	37	
6	DI-6	HI OCCUP			DO-6	38	
7	DI-7	LOW LIMIT			DO-7	39	
8	DI-8	SMOKE DET.			DO-8	41	
9	LON				20 VDC	43	
10	LON				VDC COM	44	
11							
12							
13							
14							
15	LON				24 VAC (RETURN)	45	
16	LON				24 VAC (LINE)	47	
17	AI-1	SA TEMP			E-GND	48	
18	AI-2	SPACE TEMP		SA FAN SPEED	AO-1	50	
19	AI-3				AO COM	51	
20	AI-4	EA AIR FLOW		EF FAN SPEED	AO-2	53	
21	AI-5	RETURN CO2		OA/RA DMPR	AO-3	53	
22	AI-6	PREHEAT TEM			AO COM	54	
23	AI-7	MA TEMP		PREHEAT VLV	AO-4	55	
24	AI-8	AIR FLOW		SETPT SIGNAL	AO-5	56	
25					AO COM	57	
26				HW VALVE	AO-6	58	
27							
28							
29							
30							

XL-10 REMOTE I/O DEVICE W7761A				CONTROLLER # 2			
ADDRESS : B-O-M Tag :							
RA TEMP	AI 1 OHM	+	1	EGND			4
EXHAUST TEMP	AI 2 OHM	+	5				6
HW ENT TEMP	AI 3 OHM	+	7				8
RA HUMIDITY	AI 4 OHM	+	9				10
	AI 5 V/mA	+	11				12
	AI 6 V/mA	+	13				14
	22 VDC OUT	+	15				16
	E-BUS (FTT)	+	17				18
	E-BUS (FTT)	+	19				20
	TRIAC 8	+	21				22
	TRIAC 7	+	23				24
	TRIAC 6	+	25				26
	TRIAC 5	+	27				28
	TRIAC 4	+	29				30
	TRIAC 3	+	31				32
	TRIAC 2	+	33				34
	TRIAC 1	+	35				36
	COM	+	37				38
	24 VAC IN	+	39				40
HEAT WHEEL S/S	DI 1	+	41				42
	DI 2	+	43				44
	DI 3	+	45				46
	DI 4	+	47				48

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

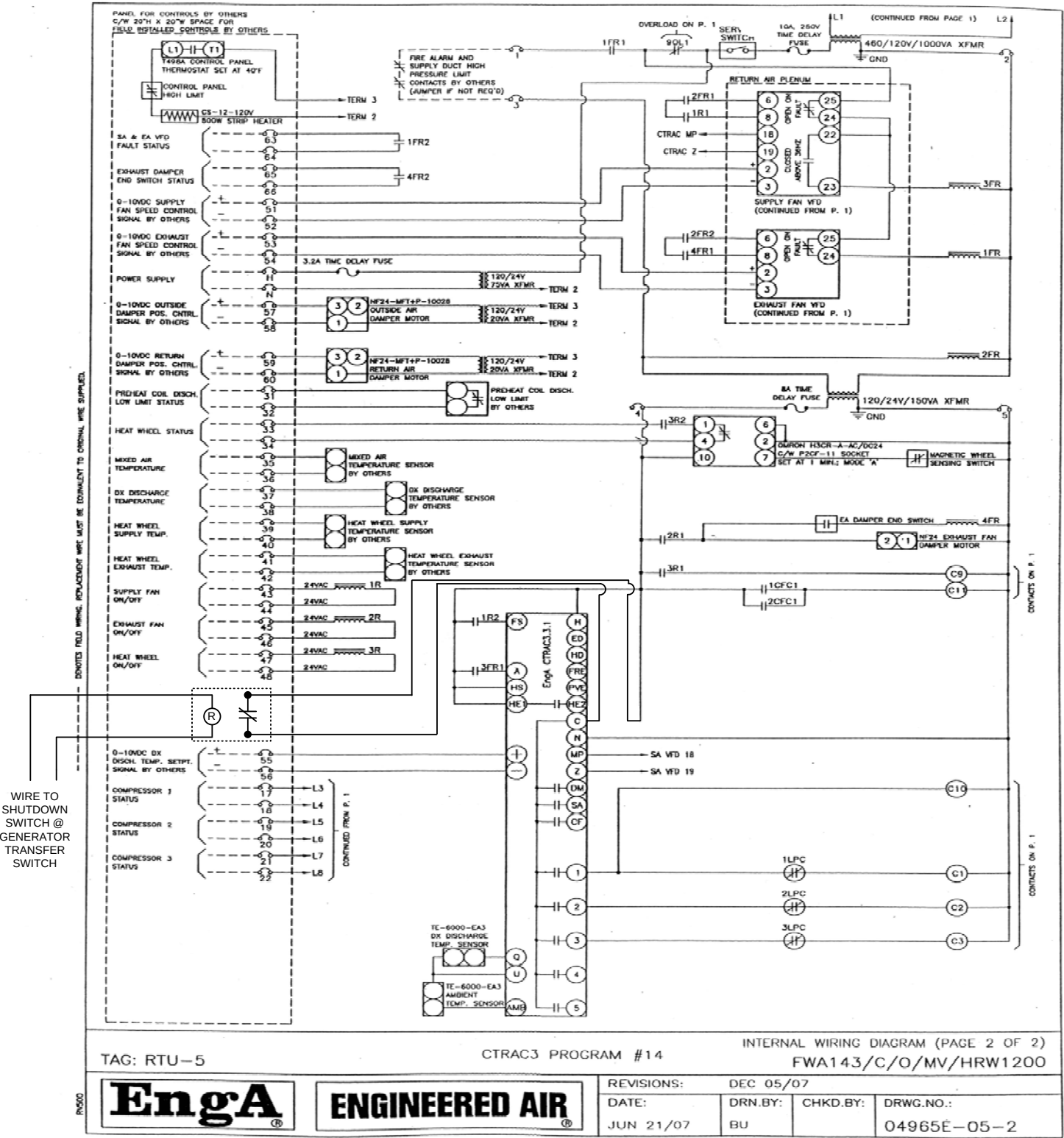
RTU-5 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	3
LLT	FREEZESTAT	DYNACON	FS-50	1
SWT	TOGGLE SWITCH	KELE	23F341	1
V1	SEE VALVE SCHEDULE			

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	ROOF TOP UNIT 5 WIRING DIAGRAM		2		ENGINEERING CHANGES		1/18/08		JBP			
			1		TERMINATION CHANGES		12/19/07		JBP			
			REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE	
	Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED			
	MH		JM		JP		BY JP DATE 06/08/07		BY DATE			
	Project Title		CHESAPEAKE CONTROLS, INC. Systems & Services Division		Branch Information		CONTRACT NUMBER					
	MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA				1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134					
					DRAWING NUMBER							
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ROOF TOP UNIT #5 SEQUENCE OF OPERATION

4.5 CONSTANT VOLUME, 100% OUTSIDE AIR HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#5, #8, #9) CONTROL (LOCKER ROOMS)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air damper will remain fully closed, the hot water reheat valve will be fully open to the coil, the energy recovery wheel will be disabled, and the supply fan will be enabled. Unit will change to "occupied" mode when return air reaches 70°F (adjustable) or when scheduled by the DDC.
- B. At "occupancy" time, the DDC Controller will enable the unit to occupancy mode energizing the supply air fan variable frequency drives and the energy recovery wheel. The variable frequency drive will index the supply fan to 100% of maximum cfm. The DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station, closing the return air damper a proportionate amount. The DDC Controller will open the exhaust air damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive.
- C. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and exhaust air cfm (90%).
- D. The air-conditioning unit has two modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled. The air-cooled condensing unit compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 2. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the air-cooled condensing unit de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled. The heating coil valve will modulate open to maintain space temperature at the setpoint of the DDC Controller.
- E. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F.
- F. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the air-cooled condensing unit section and start the compressors. The supply fan VFD will reduce the fan cfm to the 65% setting during dehumidification. Should the dehumidification process cause the space to overcool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- F. On a rise in space Carbon Dioxide to the setpoint of the DDC Controller, the DDC Controller will modulate the outside air damper between its minimum cfm and maximum cfm CO₂ damper position setpoints to maintain CO₂ setpoint.
- G. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- H. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- I. Whenever the unit is de-energized, the DDC Controller will modulate the reheat valve to maintain 55°F as sensed by the coil discharge sensors.



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Drawing Title
**ROOF TOP UNIT 5
SEQUENCE OF OPERATION**

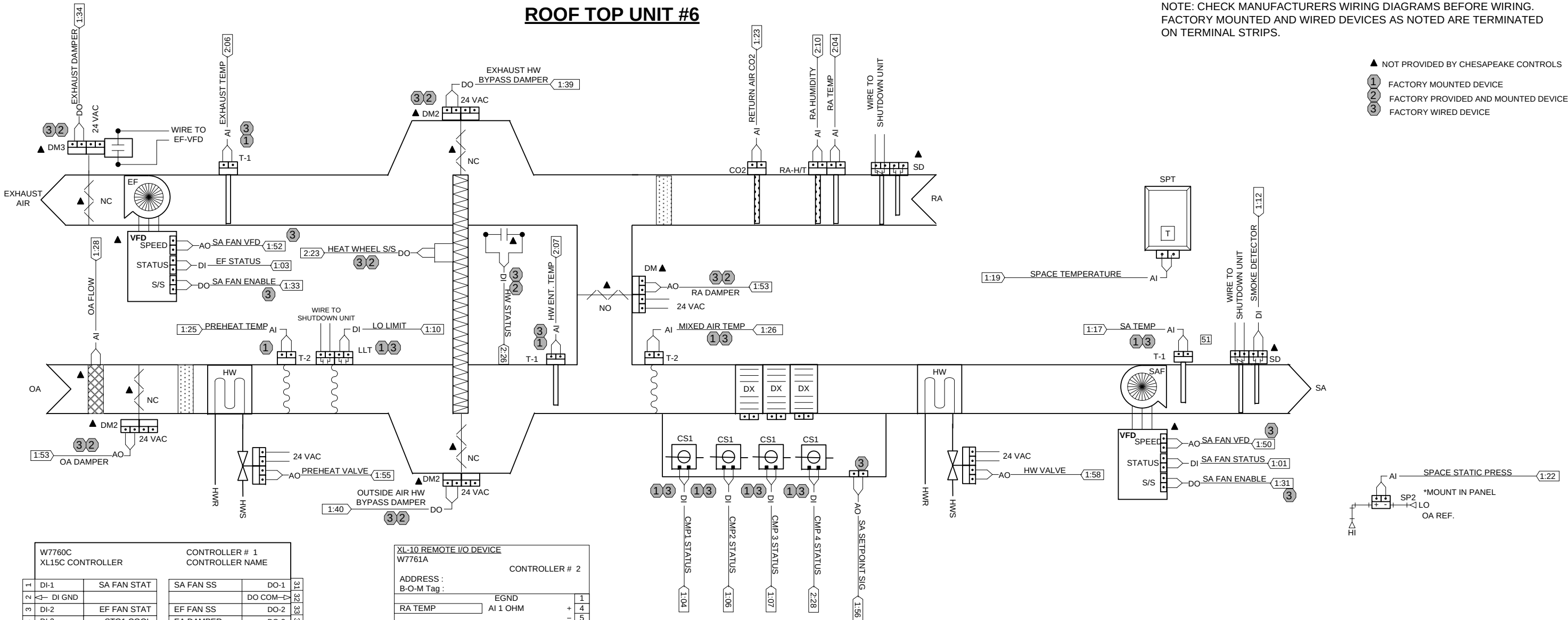
Project Title
MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA

1	GENERATOR INTERLOCK	1/02/09	JBP
1	TERMINATION CHANGES	12/19/07	JBP
REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN
SALES ENGINEER	PROJECT MANAGER	APPLICATION ENGINEER	DRAWN
MH	JM	JP	BY JP DATE 06/08/07
BRANCH INFORMATION	CONTRACT NUMBER	DRAWING NUMBER	
1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781	0830-0134	D-12	

ROOF TOP UNIT #6

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ON TERMINAL STRIPS.

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- 1 FACTORY MOUNTED DEVICE
2 FACTORY PROVIDED AND MOUNTED DEVICE
3 FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI GND		32
3	DI-2	EF FAN STAT	33
4	DI-3	STG1 COOL	34
5	DI GND		35
6	DI-4	STG2 COOL	36
7	DI-5	STG3 COOL	37
8	DI GND		38
9	DI-6		39
10	DI-7	LOW LIMIT	40
11	DI GND		41
12	DI-8	SMOKE DET.	42
13	LON		43
14	LON		44
15	LON		45
16	LON		46
17	AI-1	SA TEMP	47
18	AI GND		48
19	AI-2	SPACE TEMP	49
20	AI-3		50
21	AI GND		51
22	AI-4	SPACE STATIC	52
23	AI-5	RETURN CO2	53
24	AI GND		54
25	AI-6	PREHEAT TEM	55
26	AI-7	MA TEMP	56
27	AI GND		57
28	AI-8	AIR FLOW	58
29	GND		
30	GND		

CONTROLLER # 2	
DO-1	31
DO COM	32
DO-2	33
DO-3	34
DO COM	35
DO-4	36
DO-5	37
DO COM	38
DO-6	39
DO-7	40
DO COM	41
DO-8	42
20 VDC	43
VDC COM	44
24 VAC (RETURN)	45
24 VAC (LINE)	46
E-GND	47
SA FAN SPEED	50
AO-1	51
AO COM	52
EF FAN SPEED	53
AO-2	54
AO-3	55
AO COM	56
PREHEAT VLV	57
AO-4	58
SETPT SIGNAL	59
AO-5	60
AO COM	61
HW VALVE	62
AO-6	63

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :			
B-O-M Tag :			
RA TEMP	AI 1 OHM	+	1
EXHAUST TEMP	AI 2 OHM	+	5
HW ENT TEMP	AI 3 OHM	+	6
	AI 4 OHM	+	7
RA HUMIDITY	AI 5 V/mA	+	8
	AI 6 V/mA	+	9
	22 VDC OUT	+	10
	E-BUS (FTT)	+	11
	E-BUS (FTT)	+	12
	TRIAC 8	+	13
	TRIAC 7	+	14
	TRIAC 6	+	15
	TRIAC 5	+	16
	TRIAC 4	+	17
	TRIAC 3	+	18
	TRIAC 2	+	19
HEAT WHEEL S/S	TRIAC 1	+	20
	COM	+	21
HEAT WHEEL	DI 1	+	22
STG4 COOL	DI 2	+	23
	DI 3	+	24
	DI 4	+	25

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

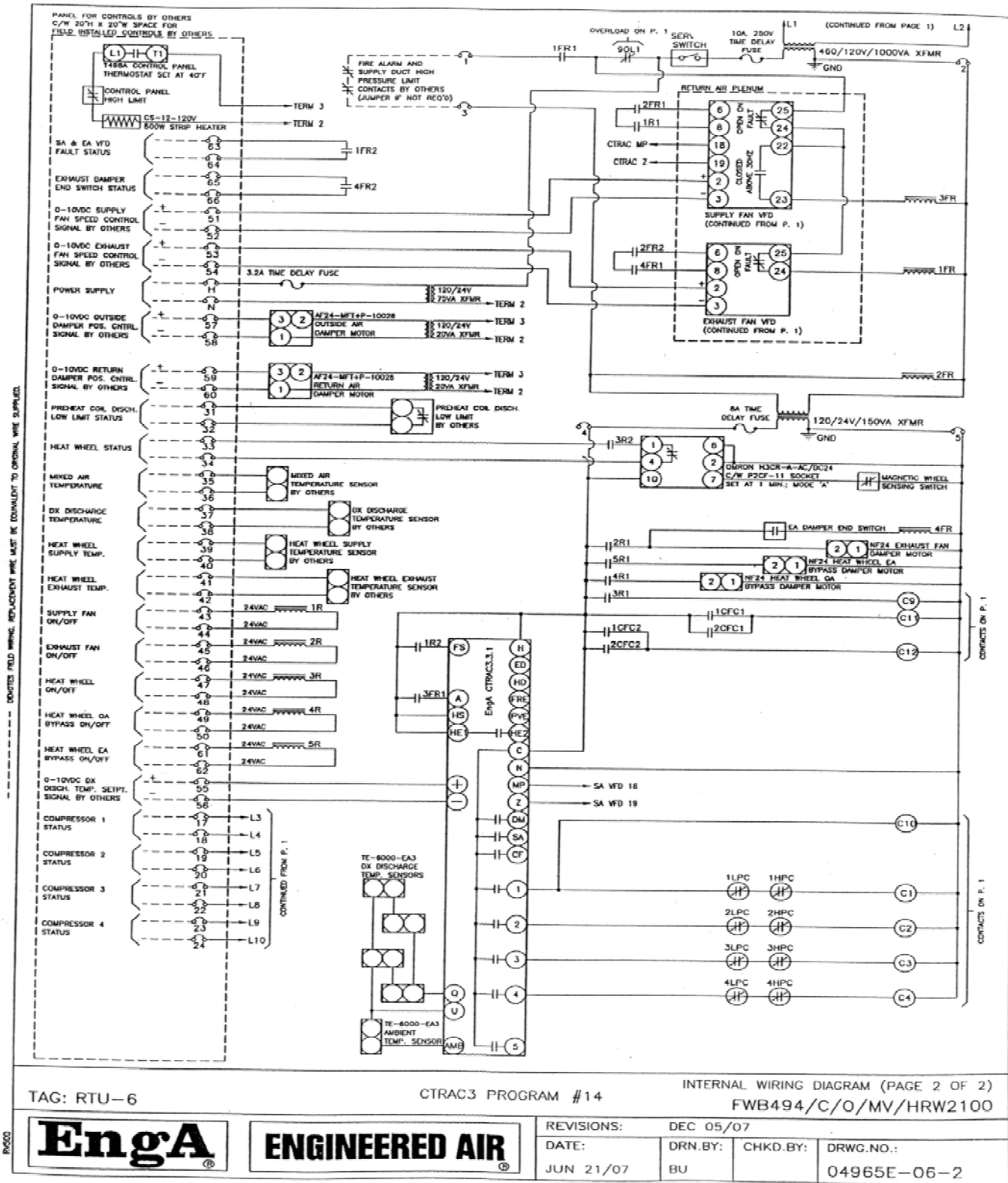
RTU-6 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
SP2	PRESSURE TRANSMITTER	VERIS	PXPLX01S	1
CS1	RELAY	VERIS	H-600	4
LLT	FREEZESTAT	DYNACON	FS-50	1

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	ROOF TOP UNIT 6 WIRING DIAGRAM		1		TERMINATION CHANGES		12/19/07 JBP	
	Project Title		MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		Branch Information		CONTRACT NUMBER	
					1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134	
					Systems & Services Division		DRAWING NUMBER	

ROOF TOP UNIT #6 SEQUENCE OF OPERATION

4.6 CONSTANT VOLUME HEAT RECOVERY ROOF UNIT (#6) CONTROL (MAIN GYM SPECTATORS)

- A. Occupied: The rooftop air-conditioning unit #7 will act as the primary heating, cooling, and outdoor air unit for the space. If the rooftop air-conditioning unit cannot maintain the space temperature, space humidity, or return CO₂ setpoint, the DDC Controller will close a set of contacts, which in turn will put the heat recovery unit in the occupied mode.
- B. At occupancy time, the DDC Controller will enable the supply air fan variable frequency drive and the energy recovery wheel. The variable frequency drive will index the supply fan to 50% of maximum cfm. The DDC Controller will modulate the Outside Air Damper open to maintain its preset minimum airflow setpoint (25% of supply air cfm) as sensed by the airflow monitoring station, closing the Return Air Damper a proportional amount. The DDC Controller will open the Exhaust Air Damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (85%).
- D. The air-conditioning unit has four modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain space temperature at the setpoint of the DDC Controller.
 4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass damper will be closed. The hot water valve will modulate open to maintain space temperature at the setpoint of the DDC Controller.
- E. If the temperature setpoint cannot be maintained, the supply fan VFD will modulate the fan speed upward to the maximum fan cfm setting as required.
- F. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the air-cooled condensing unit section and start the compressors. The supply fan VFD will maintain the fan at the 50% setting during dehumidification. Should the dehumidification process cause the space to overcool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- G. On a rise in space Carbon Dioxide to the setpoint of the DDC Controller, the DDC Controller will modulate the outside air damper between its minimum and maximum CO₂ damper position setpoints to maintain CO₂ setpoint.
- H. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- I. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- J. Whenever the unit is de-energized, the DDC Controller will modulate the reheat valve to maintain 55°F as sensed by the coil discharge sensor.
- K. The preheat coil will not be used.



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	ROOF TOP UNIT 6 SEQUENCE OF OPERATION								
		1	TERMINATION CHANGES					12/19/07	JBP
		REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN	DATE
	Project Title	Sales Engineer	Project Manager	Application Engineer		DRAWN		APPROVED	
MH		JM	JP		BY JP	DATE 06/08/07	BY	DATE	
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC. Systems & Services Division			Branch Information		CONTRACT NUMBER		
					1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134		
							DRAWING NUMBER		
							D-14		

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AIR HANDLING UNIT #7

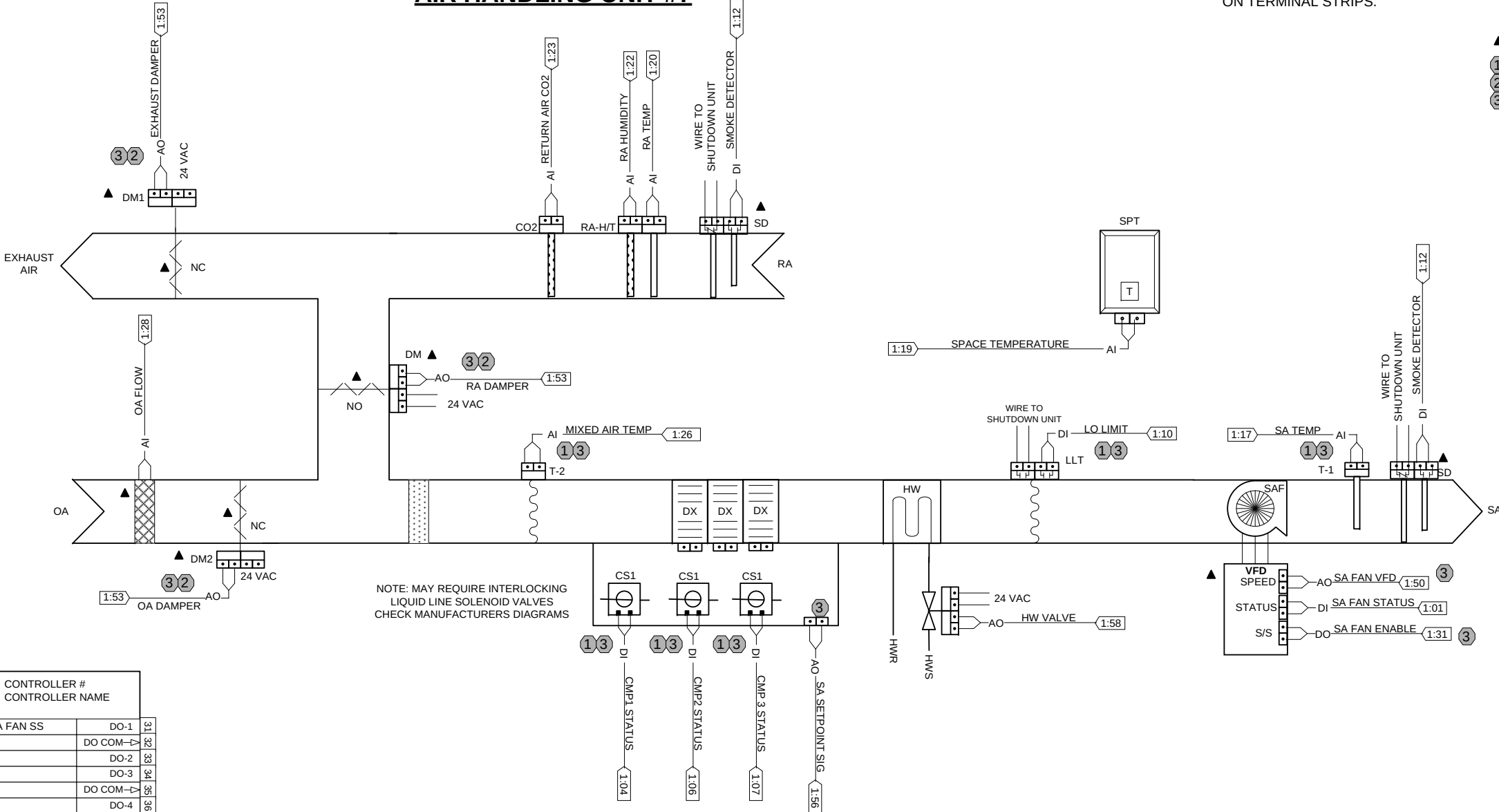
NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
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ON TERMINAL STRIPS.

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① FACTORY MOUNTED DEVICE

② FACTORY PROVIDED AND MOUNTED DEVICE

③ FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # CONTROLLER NAME	
1	DI-1	SA FAN STAT	DO-1
2	DI GND		DO COM
3	DI-2		DO-2
4	DI-3	STG1 COOL	DO-3
5	DI GND		DO COM
6	DI-4	STG2 COOL	DO-4
7	DI-5	STG3 COOL	DO-5
8	DI GND		DO COM
9	DI-6		DO-6
10	DI-7	LOW LIMIT	DO-7
11	DI GND		DO COM
12	DI-8	SMOKE DET.	DO-8
13	LON		20 VDC
14	LON		VDC COM
15	LON		24 VAC (RETURN)
16	LON	SA TEMP	24 VAC (LINE)
17	AI-1		E-GND
18	AI GND		AO-1
19	AI-2	SPACE TEMP	AO COM
20	AI-3	RA TEMP	AO-2
21	AI GND		AO-3
22	AI-4	RA HUMID	AO-4
23	AI-5	RETURN CO2	AO-5
24	AI GND		AO COM
25	AI-6		AO-4
26	AI-7	MA TEMP	SETPOINT
27	AI GND		AO COM
28	AI-8	AIR FLOW	HW VALVE
29	GND		
30	GND		

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-7 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	1
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	1
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	3
LLT	FREEZESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

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Drawing Title

ROOF TOP UNIT WIRING DIAGRA

Project Title

**MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA**

	2	TERMINATION CHANGES			04/07/08	JBP	
	1	TERMINATION CHANGES			12/19/07	JBP	
REFERENCE DRAWING		NO.	REVISION-LOCATION		ECN	DATE	BY
Sales Engineer MH	Project Manager JM	Application Engineer JP		DRAWN BY JP DATE 06/08/07	APPROVED BY _____ DATE _____		

CHESAPEAKE
CONTROLS, INC.
Systems & Services Division

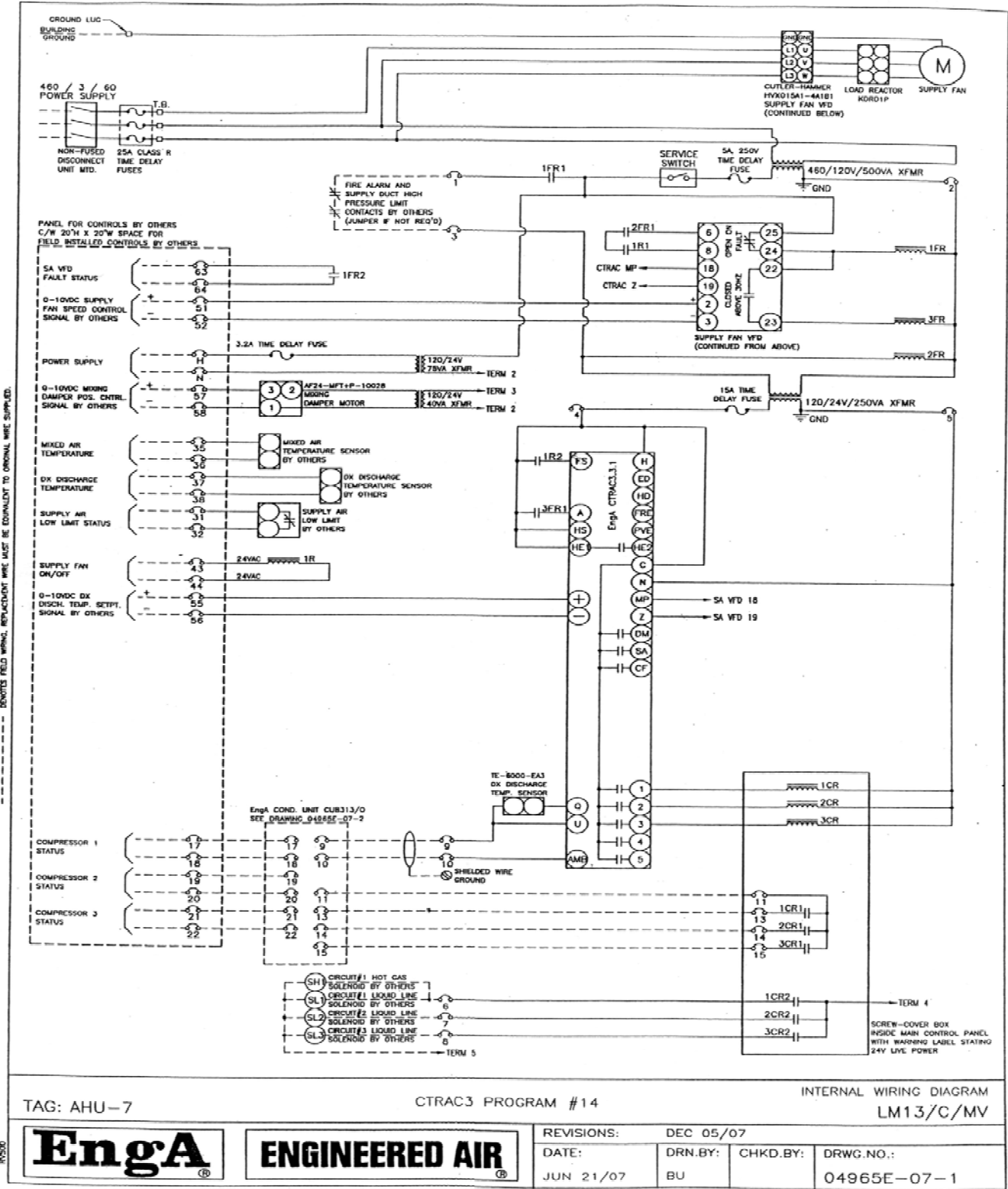
Branch Information
1220 Executive Blvd
Suite 108
Chesapeake, VA
23320
(ph) 757-547-9738
(fax) 757-547-2781

CONTRACT NUMBER
0830-0134

DRAWING NUMBER
D-15

AIR HANDLING UNIT #7 SEQUENCE OF OPERATION

- 4.4 CONSTANT VOLUME INDOOR AIR-HANDLING UNIT (#4 and #7) CONTROL (GYMNASIUMS)
- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air damper will remain fully closed, the return air damper will be fully open, and the hot water reheat valve will be fully open to the coil. The return air sensor will switch to "occupied mode" at 70°F (adjustable) or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station, closing the return air damper a proportional amount and opening the associated relief damper. The DDC Controller will signal the supply fan VFD to run the supply fan at 100% of the maximum cfm.
- C. On a rise in space temperature to the heating setpoint of the DDC Controller, the DDC Controller will modulate the hot water heating valve closed to the coil. On a further rise in space temperature, the DDC Controller will modulate the outside air damper open, closing the return air damper a proportional amount for free cooling. Whenever the setting of the mixed air temperature low limit is reached, the DDC Controller will modulate the outside air damper closed to its preset minimum position, closing the return air damper a proportional amount. Whenever the outside air temperature rises above the setpoint of the DDC Controller, the DDC Controller will disable the economizer cycle. On a further rise in space temperature, the DDC Controller will energize the remote air-cooled condensing unit section and cycle the compressors to maintain space temperature. On a fall in space temperature, the reverse sequence will occur.
- D. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the remote air-cooled condensing unit section and start the compressors. The supply fan VFD will reduce the fan speed to the 50% setting during dehumidification, and discharge temperature will be reset to 50°F. Should the dehumidification process cause the space to overcool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- E. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- F. On detection of products of combustion, the smoke detector will stop the unit supply air fan and close the outside air damper.
- G. Whenever the unit is de-energized, the DDC Controller will modulate the reheat valve to maintain 55°F as sensed by the supply air sensor.

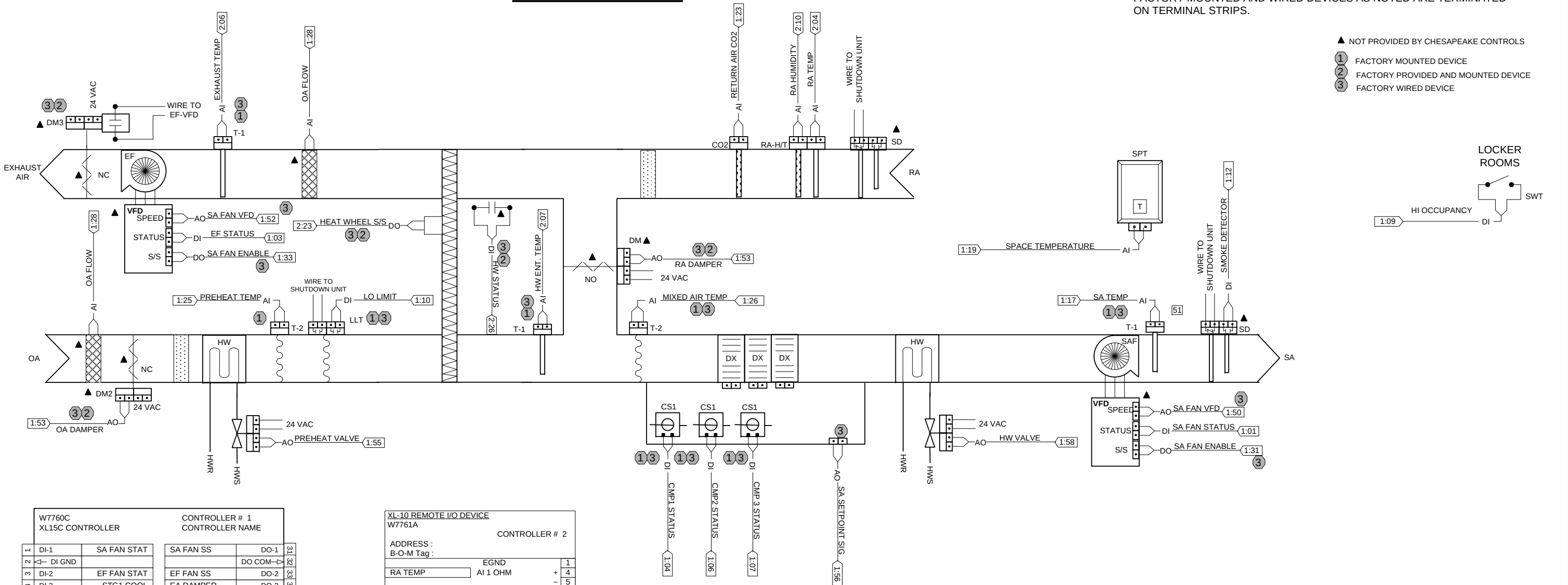


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	Project Title		MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC. Systems & Services Division		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		CONTRACT NUMBER 0830-0134	
	Drawing Number		D-16		Revision Location		ECN		DATE	
	Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED	
	MH		JM		JP		BY JP		DATE 06/08/07	

ROOF TOP UNIT #8

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- 1 FACTORY MOUNTED DEVICE
2 FACTORY PROVIDED AND MOUNTED DEVICE
3 FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI GND		32
3	DI-2	EF FAN STAT	33
4	DI-3	STG1 COOL	34
5	DI GND		35
6	DI-4	STG2 COOL	36
7	DI-5	STG3 COOL	37
8	DI GND		38
9	DI-6	HI OCCUP	39
10	DI-7	LOW LIMIT	40
11	DI GND		41
12	DI-8	SMOKE DET.	42
13	LON		43
14	LON		44
15	LON		45
16	LON		46
17	AI-1	SA TEMP	47
18	AI GND		48
19	AI-2	SPACE TEMP	49
20	AI-3		50
21	AI GND		51
22	AI-4	EA AIRFLOW	52
23	AI-5	RETURN CO2	53
24	AI GND		54
25	AI-6	PREHEAT TEM	55
26	AI-7	MA TEMP	56
27	AI GND		57
28	AI-8	AIR FLOW	58
29	GND		
30	GND		

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :			
B-O-M Tag :			
RA TEMP	AI 1 OHM	+	1
EXHAUST TEMP	AI 2 OHM	+	4
HW ENT TEMP	AI 3 OHM	+	5
	AI 4 OHM	+	6
RA HUMIDITY	AI 5 V/mA	+	7
	AI 6 V/mA	+	8
	22 VDC OUT	+	9
	E-BUS (FTT)	+	10
	E-BUS (FTT)	+	11
	TRIAC 8	+	12
	TRIAC 7	+	13
	TRIAC 6	+	14
	TRIAC 5	+	15
	TRIAC 4	+	16
	TRIAC 3	+	17
	TRIAC 2	+	18
HEAT WHEEL S/S	TRIAC 1	+	19
	COM	+	20
HEAT WHEEL	DI 1	+	21
	DI 2	+	22
	DI 3	+	23
	DI 4	+	24

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-8 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEM P SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	3
LLT	FREEZESTAT	DYNACON	FS-50	1
SWT	TOGGLE SWITCH	KELE	23F341	1
V1	SEE VALVE SCHEDULE			

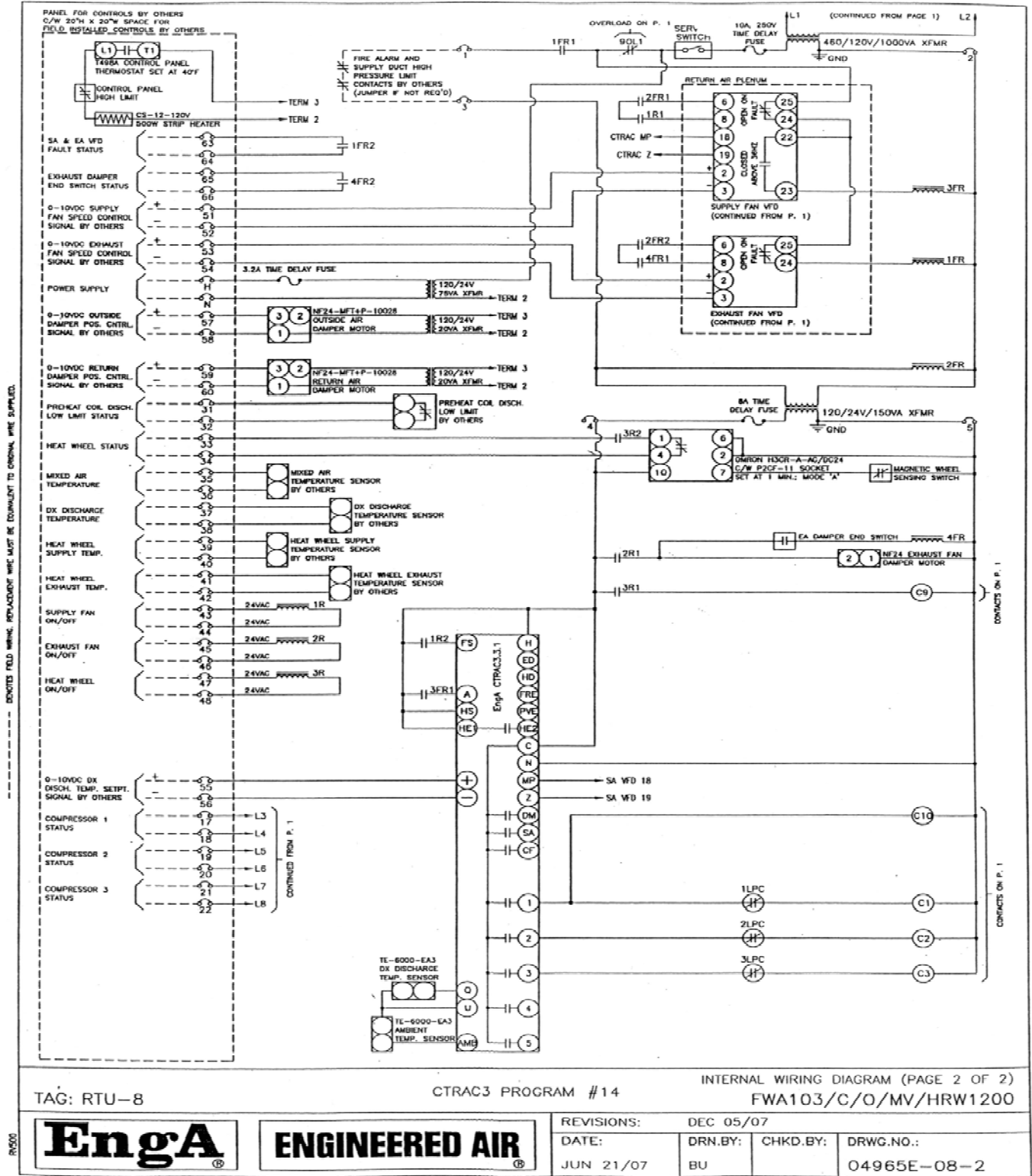
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Drawing Title		2		ENGINEERING CHANGES		1/18/08		JBP	
ROOF TOP UNIT 8 WIRING DIAGRAM		1		TERMINATION CHANGES		12/19/07		JBP	
REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE	
Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED	
MH		JM		JP		BY JP		DATE 06/08/07	
Project Title		Branch Information		CONTRACT NUMBER		DATE		DATE	
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134		D-17			
		CHESAPEAKE CONTROLS, INC.		Systems & Services Division					

ROOF TOP UNIT #8 SEQUENCE OF OPERATION

- 4.5 CONSTANT VOLUME, 100% OUTSIDE AIR HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#5, #8, #9) CONTROL (LOCKER ROOMS)
- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air damper will remain fully closed, the hot water reheat valve will be fully open to the coil, the energy recovery wheel will be disabled, and the supply fan will be enabled. Unit will change to "occupied" mode when return air reaches 70°F (adjustable) or when scheduled by the DDC.
- B. At "occupancy" time, the DDC Controller will enable the unit to occupancy mode energizing the supply air fan variable frequency drives and the energy recovery wheel. The variable frequency drive will index the supply fan to 100% of maximum cfm. The DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station, closing the return air damper a proportionate amount. The DDC Controller will open the exhaust air damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive.
- C. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and exhaust air cfm (90%).
- D. The air-conditioning unit has two modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled. The air-cooled condensing unit compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 2. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the air-cooled condensing unit de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled. The heating coil valve will modulate open to maintain space temperature at the setpoint of the DDC Controller.
- E. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F.
- F. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the air-cooled condensing unit section and start the compressors. The supply fan VFD will reduce the fan cfm to the 65% setting during dehumidification. Should the dehumidification process cause the space to overcool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- F. On a rise in space Carbon Dioxide to the setpoint of the DDC Controller, the DDC Controller will modulate the outside air damper between its minimum cfm and maximum cfm CO₂ damper position setpoints to maintain CO₂ setpoint.
- G. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- H. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- I. Whenever the unit is de-energized, the DDC Controller will modulate the reheat valve to maintain 55°F as sensed by the coil discharge sensors.



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Drawing Title

ROOF TOP UNIT 8 SEQUENCE OF OPERATION

Project Title

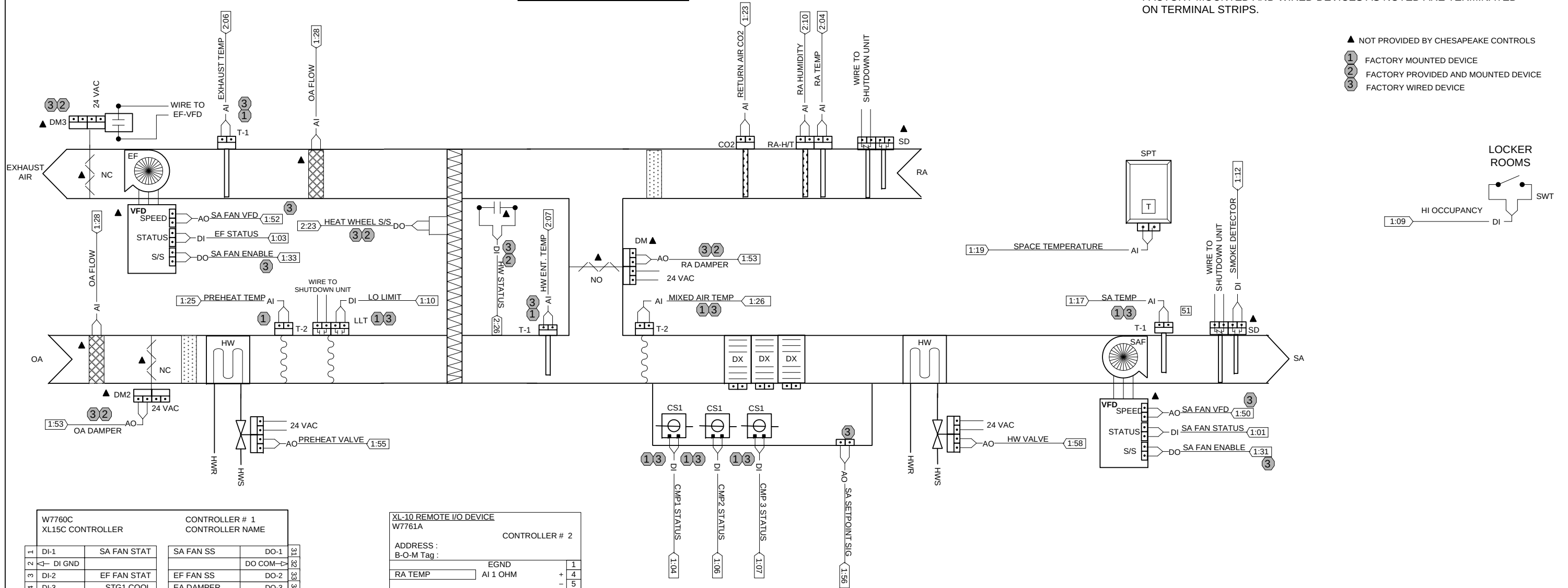
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA

1	TERMINATION CHANGES	12/19/07	JBP
REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN
SALES ENGINEER	PROJECT MANAGER	APPLICATION ENGINEER	DRAWN
MH	JM	JP	JP
DATE	DATE	DATE	DATE
		06/08/07	
BRANCH INFORMATION	CONTRACT NUMBER	DRAWING NUMBER	
1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781	0830-0134	D-18	

ROOF TOP UNIT #9

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- | | |
|---|-------------------------------------|
| 1 | FACTORY MOUNTED DEVICE |
| 2 | FACTORY PROVIDED AND MOUNTED DEVICE |
| 3 | FACTORY WIRED DEVICE |



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	SA FAN SS
2	DI-2	EF FAN STAT	DO-1
3	DI-3	STG1 COOL	DO COM
4	DI-4	STG2 COOL	DO-2
5	DI-5	STG3 COOL	DO-3
6	DI-6	HI OCCUP	DO COM
7	DI-7	LOW LIMIT	DO-4
8	DI-8	SMOKE DET.	DO-5
9	LON		DO COM
10	LON		DO-6
11			DO-7
12			DO COM
13			DO-8
14			20 VDC
15			VDC COM
16			
17			
18			
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XL-10 REMOTE I/O DEVICE		CONTROLLER # 2	
W7761A			
ADDRESS :			
B-O-M Tag :			
RA TEMP	AI 1 OHM	+	4
		-	5
EXHAUST TEMP	AI 2 OHM	+	6
HW ENT TEMP	AI 3 OHM	+	7
		-	8
	AI 4 OHM	+	9
RA HUMIDITY	AI 5 VmA	+	10
		-	11
	AI 6 VmA	+	12
	22 VDC OUT	+	13
	E-BUS (FTT)	+	14
	E-BUS (FTT)	+	15
	TRIAC 8	—	16
	TRIAC 7	—	17
	TRIAC 6	—	18
	TRIAC 5	—	19
	TRIAC 4	—	20
	TRIAC 3	—	21
	TRIAC 2	—	22
HEAT WHEEL S/S	TRIAC 1	—	23
	COM		24
	24 VAC IN		25
HEAT WHEEL	DI 1	+	26
		+	27
	DI 2	+	28
	DI 3	+	29
		+	30
	DI 4	+	31

**SEE NEXT PAGE FOR SEQUENCE OF OPERATION*

RTU-9 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	3
LLT	FREEZESTAT	DYNACON	FS-50	1
SWT	TOGGLE SWITCH	KELE	23F341	1
V1	SEE VALVE SCHEDULE			

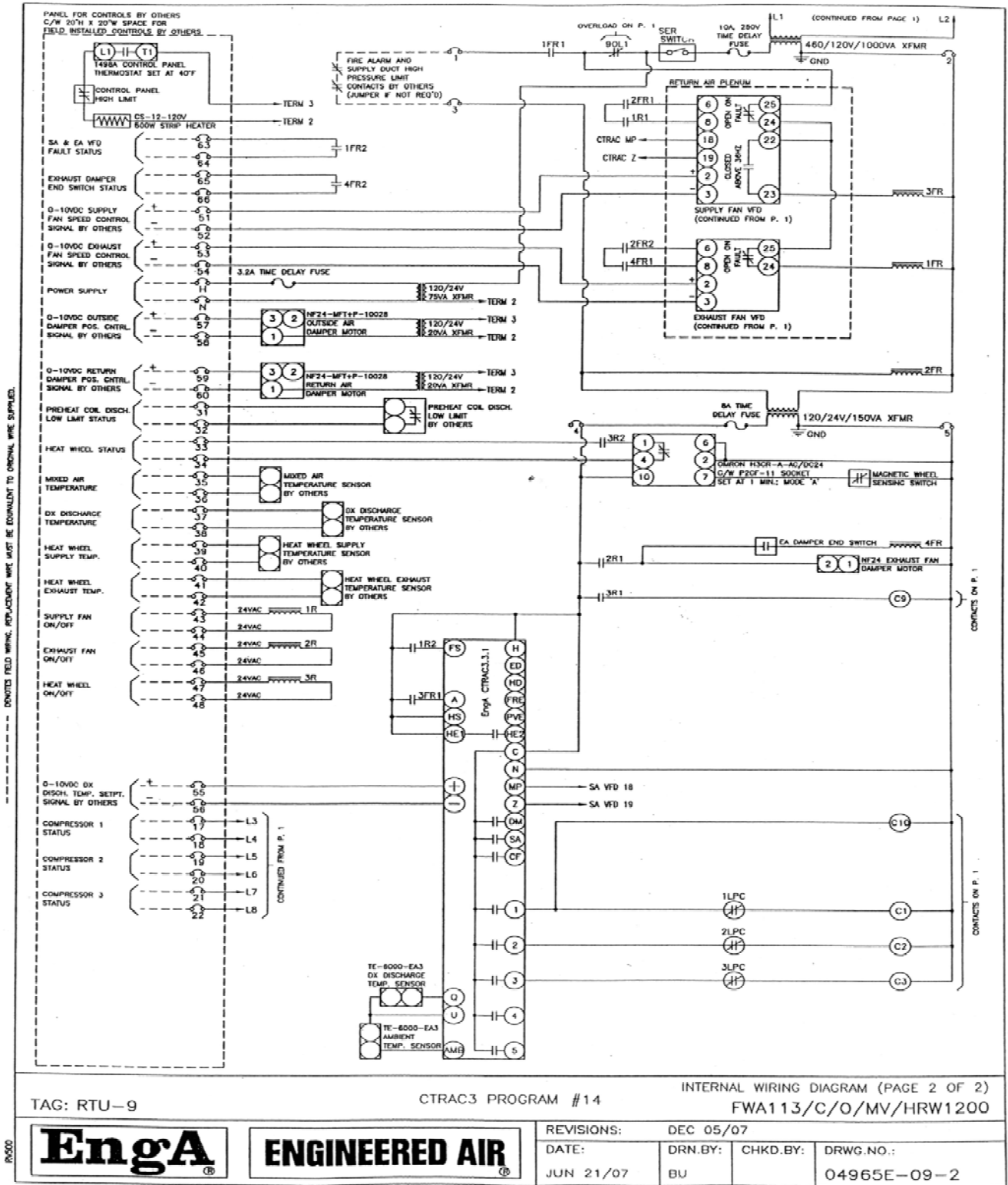
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DEMAND

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Drawing Title ROOF TOP UNIT 9 WIRING DIAGRAM						
		2	ENGINEERING CHANGES		1/18/08	JBP
		1	TERMINATION CHANGES		12/19/07	JBP
	REFERENCE DRAWING		NO.	REVISION-LOCATION		ECN
						DATE
Sales Engineer		Project Manager	Application Engineer	DRAWN		APPROVED
MH		JM	JP	BY JP	DATE 06/08/07	BY DATE
Project Title MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA				Branch Information		CONTRACT NUMBER
				1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134
						DRAWING NUMBER
					D-19	

ROOF TOP UNIT #9 SEQUENCE OF OPERATION

- 4.5 CONSTANT VOLUME, 100% OUTSIDE AIR HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#5, #8, #9) CONTROL (LOCKER ROOMS)
- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air damper will remain fully closed, the hot water reheat valve will be fully open to the coil, the energy recovery wheel will be disabled, and the supply fan will be enabled. Unit will change to "occupied" mode when return air reaches 70°F (adjustable) or when scheduled by the DDC.
- B. At "occupancy" time, the DDC Controller will enable the unit to occupancy mode energizing the supply air fan variable frequency drives and the energy recovery wheel. The variable frequency drive will index the supply fan to 100% of maximum cfm. The DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station, closing the return air damper a proportionate amount. The DDC Controller will open the exhaust air damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive.
- C. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and exhaust air cfm (90%).
- D. The air-conditioning unit has two modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled. The air-cooled condensing unit compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 2. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the air-cooled condensing unit de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled. The heating coil valve will modulate open to maintain space temperature at the setpoint of the DDC Controller.
- E. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F.
- F. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the air-cooled condensing unit section and start the compressors. The supply fan VFD will reduce the fan cfm to the 65% setting during dehumidification. Should the dehumidification process cause the space to overcool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- F. On a rise in space Carbon Dioxide to the setpoint of the DDC Controller, the DDC Controller will modulate the outside air damper between its minimum cfm and maximum cfm CO₂ damper position setpoints to maintain CO₂ setpoint.
- G. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- H. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- I. Whenever the unit is de-energized, the DDC Controller will modulate the reheat valve to maintain 55°F as sensed by the coil discharge sensors.



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Drawing Title
**ROOF TOP UNIT 9
SEQUENCE OF OPERATION**

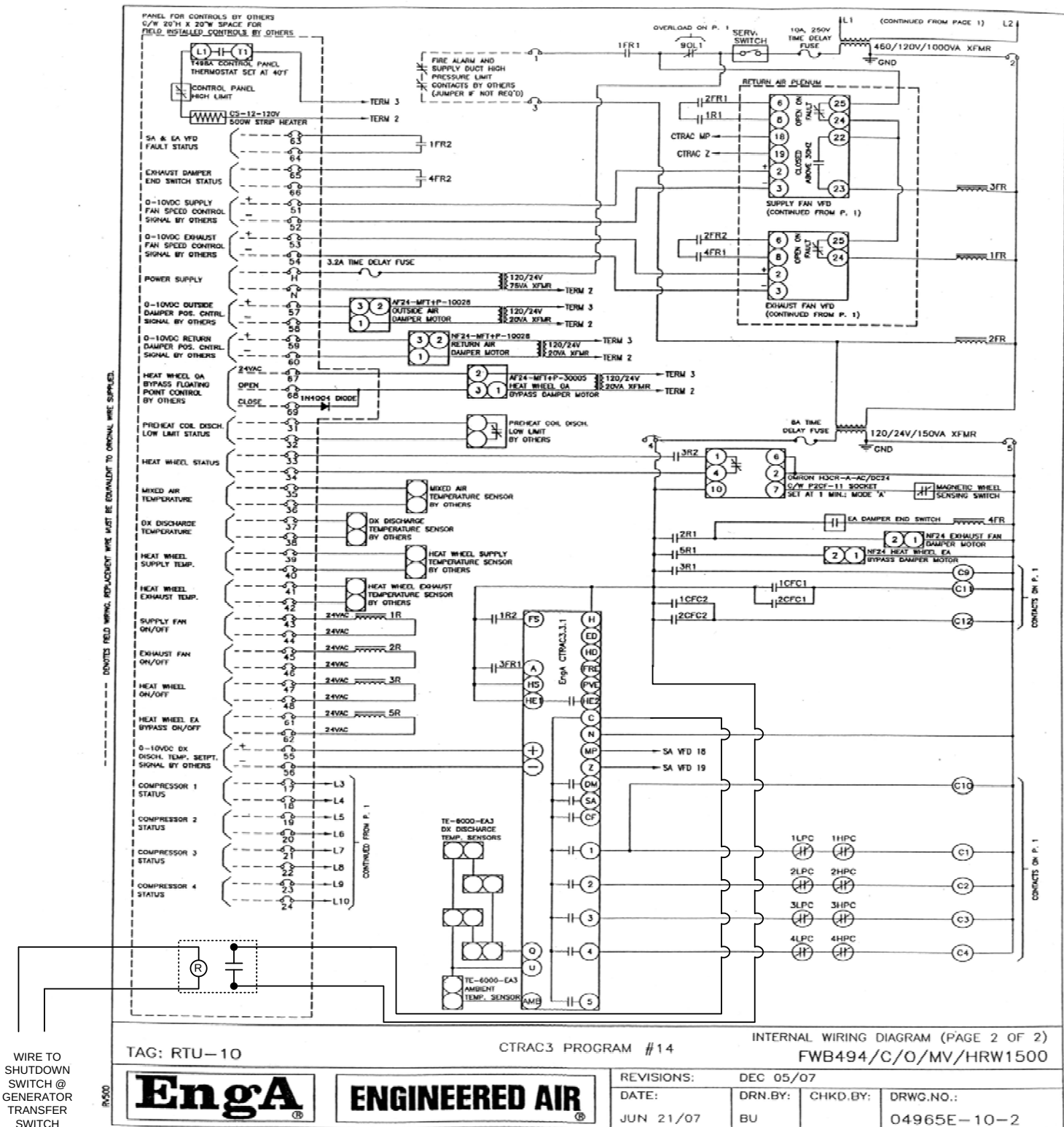
Project Title
**MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA**

1		TERMINATION CHANGES	12/19/07	JBP
REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE
Sales Engineer	Project Manager	Application Engineer	DATE	APPROVED
MH	JM	JP	BY JP DATE 06/08/07	BY DATE
1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		CONTRACT NUMBER 0830-0134		
Systems & Services Division		DRAWING NUMBER D-20		

ROOF TOP UNIT #10 SEQUENCE OF OPERATION

VARIABLE AIR VOLUME, HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#1, #10, #11, #15, #16, #17)
CONTROL (CLASSROOMS AND ADMINISTRATION/MEDIA CENTER)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air, exhaust, and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the energy recovery wheel will be disabled, and the supply fan will be enabled. Unit supply air temperature will be reset upward to 80°F (adjustable). Unit will change to "occupied mode" when return air temperature reaches 70°F (adjustable), or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan and the energy recovery wheel. The DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station closing the return air damper a proportional amount. The DDC Controller will open the exhaust air damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. Supply fan speed will be controlled to maintain down duct supply air static pressure setpoint. System will monitor the primary air valve position on all terminal variable air volume boxes and reset the supply duct static pressure setpoint so that at least one terminal VAV boxes primary air valve is at least 95% open. If the discharge static pressure rises above the static high-pressure setpoint, (4" wc adjustable) supply fan will be disabled. Manual reset will be required to restart unit.
- D. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- E. The air-conditioning unit has four modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain the discharge air temperature (50°F adjustable). The discharge air temperature will be reset from the space having the highest cooling demand.
 4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the mixed air temperature is below the discharge air temperature setpoint (50°F adjustable), the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper, and the Outside Air Recovery Bypass Damper will be closed. The preheat valve will modulate open to maintain discharge air temperature of 50°F (adjustable) setpoint of the DDC Controller.
- F. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge air temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F. If the temperature, measured downstream of the heat recovery wheel, rises above the unit discharge air temperature setpoint, then the Outside Air Recovery Bypass Damper shall modulate open to bypass the preheated air around the heat recovery wheel.
- G. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- H. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- I. Whenever the unit is de-energized, the DDC Controller will modulate the preheat valve to maintain 50°F as sensed by the preheat coil discharge sensor.
- J. The mechanical cooling will be locked out if the supply fan cfm falls below 40% of maximum. The fan rpm that results in this cfm value shall be determined during the unit fan balancing.

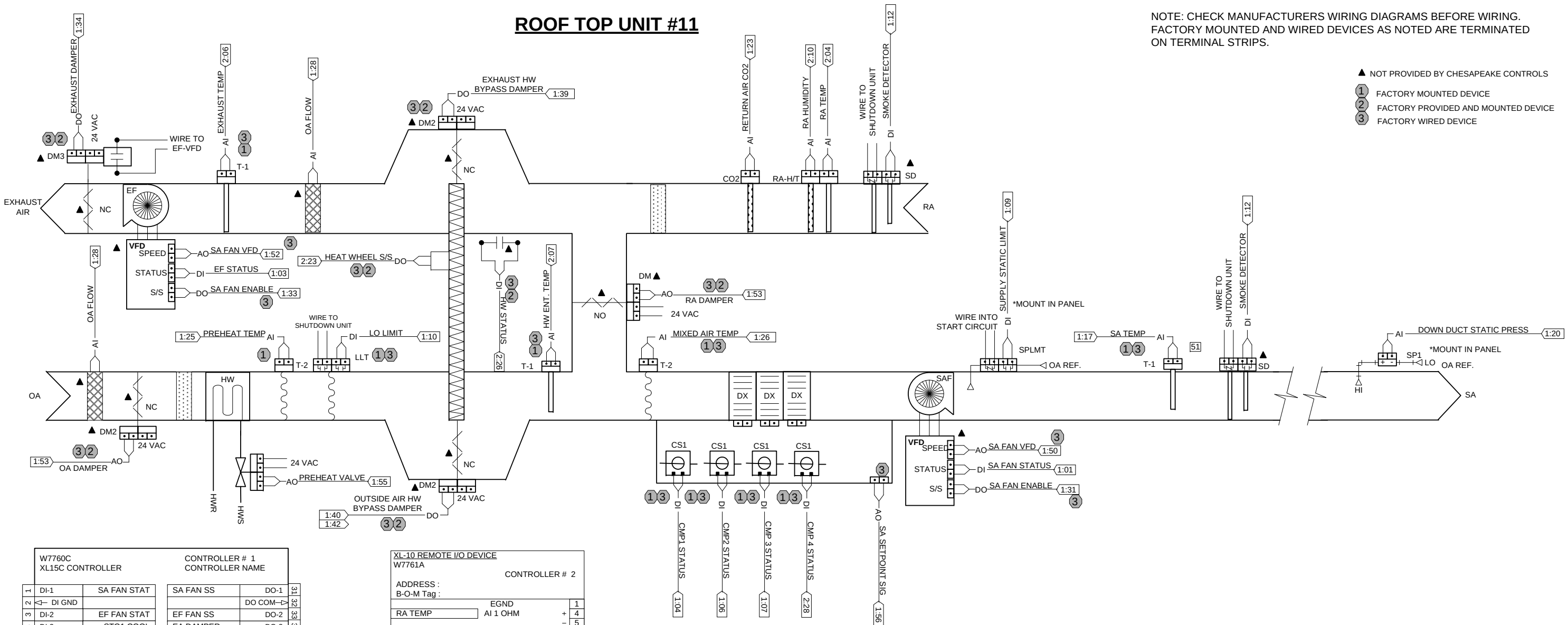


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	ROOF TOP UNIT 10 SEQUENCE OF OPERATION				1		GENERATOR INTERLOCK				1/02/09 JBP			
					1		TERMINATION CHANGES				12/19/07 JBP			
			REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE		BY	
			Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED			
			MH		JM		JP		BY JP DATE 06/08/07		BY DATE			
	Project Title						Branch Information		CONTRACT NUMBER					
	MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC.		Systems & Services Division		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134					
									DRAWING NUMBER					
									D-22					
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ROOF TOP UNIT #11

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- ① FACTORY MOUNTED DEVICE
② FACTORY PROVIDED AND MOUNTED DEVICE
③ FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	DO-1
2	DI GND		DO COM
3	DI-2	EF FAN STAT	DO-2
4	DI-3	STG1 COOL	DO-3
5	DI GND		DO COM
6	DI-4	STG2 COOL	DO-4
7	DI-5	STG3 COOL	DO-5
8	DI GND		DO COM
9	DI-6	HI STATIC LMT	DO-6
10	DI-7	LOW LIMIT	DO-7
11	DI GND		DO COM
12	DI-8	SMOKE DET.	DO-8
13	LON		20 VDC
14	LON		VDC COM
15	LON		24 VAC (RETURN)
16	LON		24 VAC (LINE)
17	AI-1	SA TEMP	
18	AI GND		E-GND
19	AI-2		
20	AI-3	DUCT STATIC	SA FAN SPEED AO-1
21	AI GND		AO COM
22	AI-4	EA AIR FLOW	EF FAN SPEED AO-2
23	AI-5	RETURN CO2	OA/RA DMPR AO-3
24	AI GND		AO COM
25	AI-6	PREHEAT TEM	PREHEAT VLV AO-4
26	AI-7	MA TEMP	SETPT SIGNAL AO-5
27	AI GND		AO COM
28	AI-8	AIR FLOW	
29	GND		AO-6
30	GND		

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :			
B-O-M Tag :			
RA TEMP	AI 1 OHM	+	1
EXHAUST TEMP	AI 2 OHM	+	4
HW ENT TEMP	AI 3 OHM	+	5
	AI 4 OHM	+	6
RA HUMIDITY	AI 5 V/mA	+	7
	AI 6 V/mA	+	8
	22 VDC OUT	+	9
	E-BUS (FTT)	+	10
	E-BUS (FTT)	+	11
	TRIAC 8	+	12
	TRIAC 7	+	13
	TRIAC 6	+	14
	TRIAC 5	+	15
	TRIAC 4	+	16
	TRIAC 3	+	17
	TRIAC 2	+	18
HEAT WHEEL S/S	TRIAC 1	+	19
	COM	+	20
HEAT WHEEL	DI 1	+	21
STG4 COOL	DI 2	+	22
	DI 3	+	23
	DI 4	+	24

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-11 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
SP1	PRESSURE TRANSMITTER	VERIS	PXPLX02S	1
SPLMT	STATIC PRRESSURE HI LIMIT	DYNACON	AFS-460-DSS	1
CS1	RELAY	VERIS	H-600	4
LLT	FREEZESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

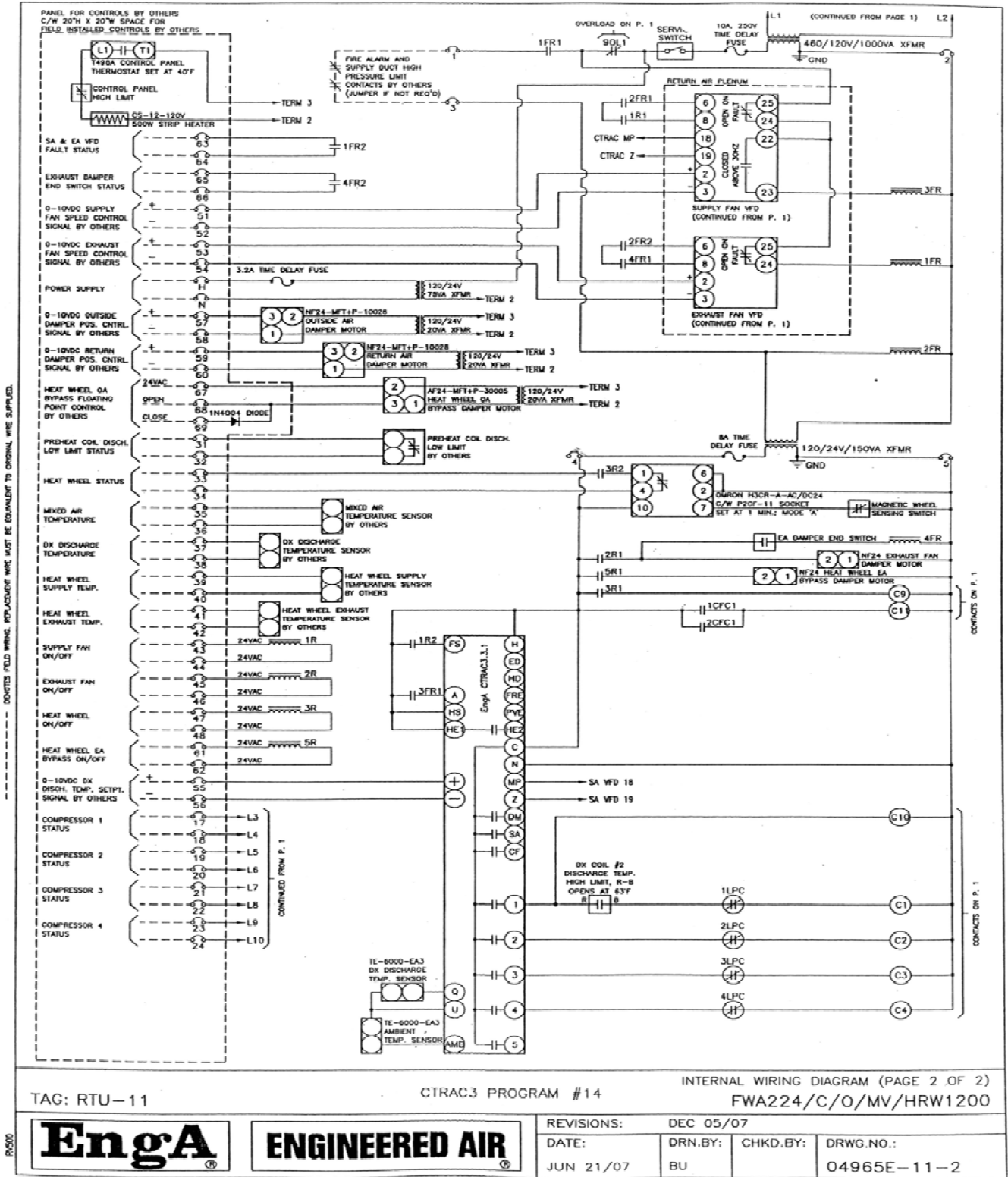
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Drawing Title		2		ENGINEERING CHANGES		1/18/08		JBP	
ROOF TOP UNIT 11 WIRING DIAGRAM		1		TERMINATION CHANGES		12/19/07		JBP	
Project Title		MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		REFERENCE DRAWING		NO.		REVISION-LOCATION	
				Sales Engineer		Project Manager		Application Engineer	
				MH		JM		JP	
				BY		DATE		06/08/07	
				BY		DATE			
				Branch Information		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		CONTRACT NUMBER	
				CHESAPEAKE CONTROLS, INC.		Systems & Services Division		0830-0134	
								DRAWING NUMBER	
								D-23	

ROOF TOP UNIT #11 SEQUENCE OF OPERATION

VARIABLE AIR VOLUME, HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#1, #10, #11, #15, #16, #17)
CONTROL (CLASSROOMS AND ADMINISTRATION/MEDIA CENTER)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air, exhaust, and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the energy recovery wheel will be disabled, and the supply fan will be enabled. Unit supply air temperature will be reset upward to 80°F (adjustable). Unit will change to "occupied mode" when return air temperature reaches 70°F (adjustable), or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan and the energy recovery wheel. The DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station closing the return air damper a proportional amount. The DDC Controller will open the exhaust air damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. Supply fan speed will be controlled to maintain down duct supply air static pressure setpoint. System will monitor the primary air valve position on all terminal variable air volume boxes and reset the supply duct static pressure setpoint so that at least one terminal VAV boxes primary air valve is at least 95% open. If the discharge static pressure rises above the static high-pressure setpoint, (4" wc adjustable) supply fan will be disabled. Manual reset will be required to restart unit.
- D. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- E. The air-conditioning unit has four modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain the discharge air temperature (50°F adjustable). The discharge air temperature will be reset from the space having the highest cooling demand.
 4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the mixed air temperature is below the discharge air temperature setpoint (50°F adjustable), the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper, and the Outside Air Recovery Bypass Damper will be closed. The preheat valve will modulate open to maintain discharge air temperature of 50°F (adjustable) setpoint of the DDC Controller.
- F. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge air temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F. If the temperature, measured downstream of the heat recovery wheel, rises above the unit discharge air temperature setpoint, then the Outside Air Recovery Bypass Damper shall modulate open to bypass the preheated air around the heat recovery wheel.
- G. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- H. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- I. Whenever the unit is de-energized, the DDC Controller will modulate the preheat valve to maintain 50°F as sensed by the preheat coil discharge sensor.
- J. The mechanical cooling will be locked out if the supply fan cfm falls below 40% of maximum. The fan rpm that results in this cfm value shall be determined during the unit fan balancing.

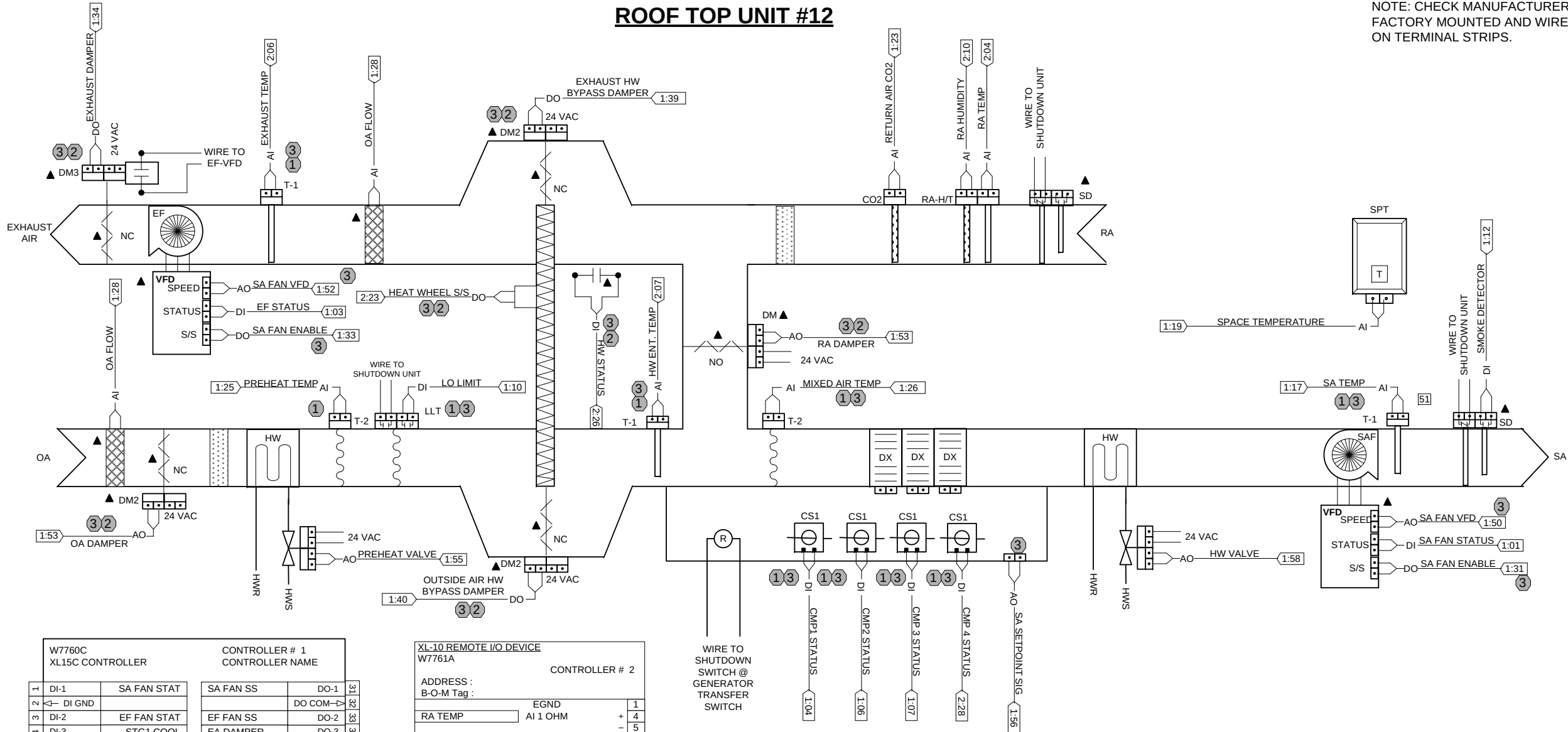


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	ROOF TOP UNIT 1 SEQUENCE OF OPERATION		1		TERMINATION CHANGES		12/19/07		JBP			
			REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN	DATE	BY	
			Sales Engineer MH		Project Manager JM		Application Engineer JP		DRAWN BY JP DATE 06/08/07		APPROVED BY DATE	
	Project Title		CHESAPEAKE CONTROLS, INC. Systems & Services Division				Branch Information				CONTRACT NUMBER	
	MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA						1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781				0830-0134	
											DRAWING NUMBER	
							D-24					
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ROOF TOP UNIT #12

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- 1 FACTORY MOUNTED DEVICE
2 FACTORY PROVIDED AND MOUNTED DEVICE
3 FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI GND		32
3	DI-2	EF FAN STAT	33
4	DI-3	STG1 COOL	34
5	DI GND		35
6	DI-4	STG2 COOL	36
7	DI-5	STG3 COOL	37
8	DI GND		38
9	DI-6		39
10	DI-7	LOW LIMIT	40
11	DI GND		41
12	DI-8	SMOKE DET.	42
13	LON		43
14	LON		44
15	LON		45
16	LON		46
17	AI-1	SA TEMP	47
18	AI GND		48
19	AI-2	SPACE TEMP	49
20	AI-3		50
21	AI GND		51
22	AI-4	EA AIR FLOW	52
23	AI-5	RETURN CO2	53
24	AI GND		54
25	AI-6	PREHEAT TEM	55
26	AI-7	MA TEMP	56
27	AI GND		57
28	AI-8	AIR FLOW	58
29	GND		
30	GND		

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :			
B-O-M Tag :			
RA TEMP	AI 1 OHM	+	4
EXHAUST TEMP	AI 2 OHM	+	5
HW ENT TEMP	AI 3 OHM	+	6
	DO-4	-	7
	DO-5	-	8
RA HUMIDITY	AI 4 OHM	+	9
	AI 5 V/mA	+	10
	AI 6 V/mA	+	11
	22 VDC OUT	+	12
	E-BUS (FTT)	+	13
	E-BUS (FTT)	+	14
	TRIAC 8	+	15
	TRIAC 7	+	16
	TRIAC 6	+	17
	TRIAC 5	+	18
	TRIAC 4	+	19
	TRIAC 3	+	20
	TRIAC 2	+	21
HEAT WHEEL S/S	TRIAC 1	+	22
	COM	+	23
	24 VAC IN	+	24
HEAT WHEEL	DI 1	+	25
STG4 COOL	DI 2	+	26
	DI 3	+	27
	DI 4	+	28
		+	29
		+	30
		+	31

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-12 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	4
LLT	FREESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

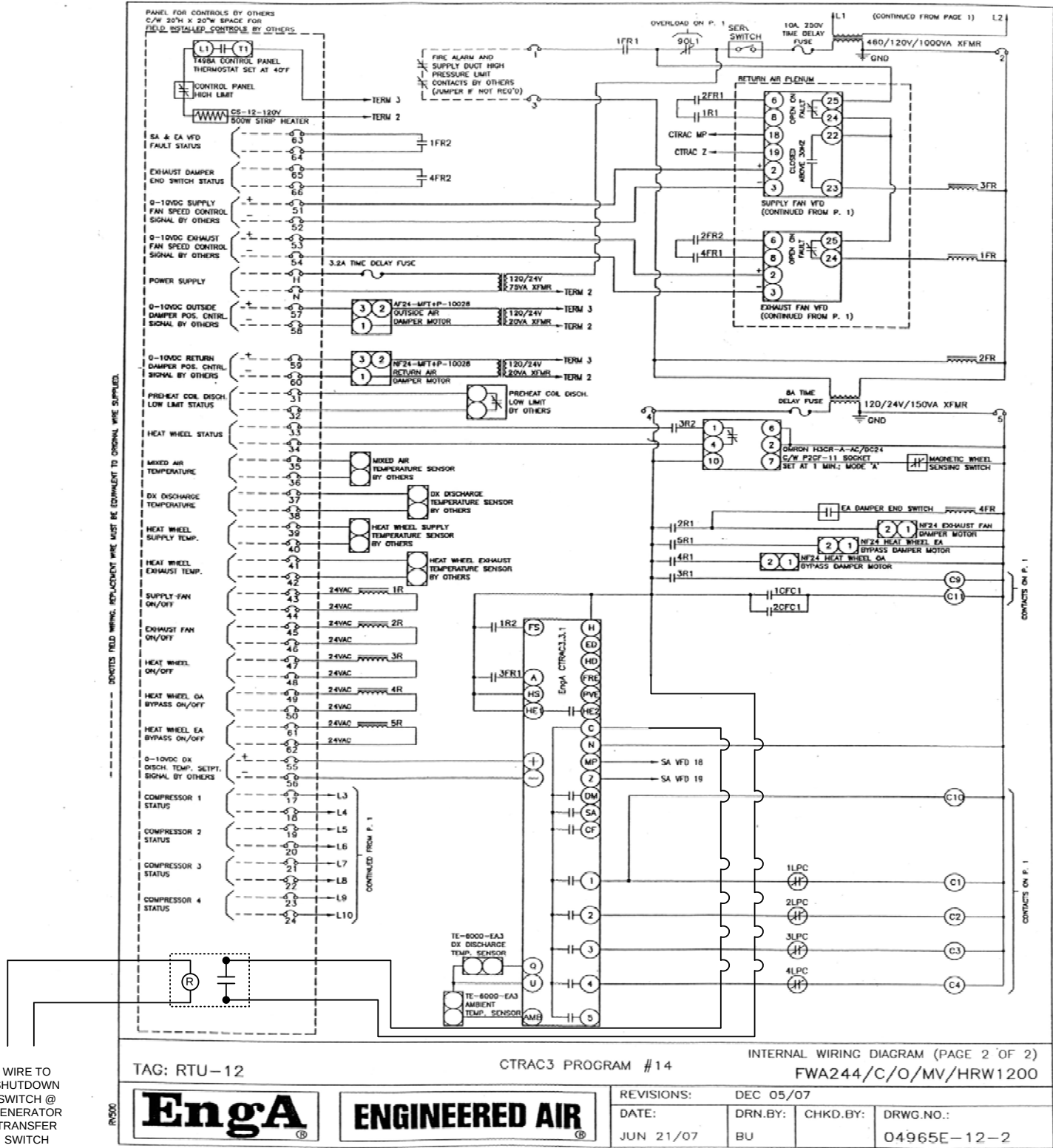
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Drawing Title		1	GENERATOR INTERLOCK	1/02/09	JBP
ROOF TOP UNIT 12 WIRING DIAGRAM		2	ENGINEERING CHANGES	1/18/08	JBP
		1	TERMINATION CHANGES	12/19/07	JBP
		REFERENCE DRAWING			
Project Title		NO.	REVISION-LOCATION	ECN	DATE
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		Sales Engineer	Project Manager	Application Engineer	DATE
		MH	JM	JP	06/08/07
		Branch Information		CONTRACT NUMBER	
		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134	
		CHESAPEAKE CONTROLS, INC. Systems & Services Division		DRAWING NUMBER D-25	

ROOF TOP UNIT #12 SEQUENCE OF OPERATION

- 4.2 CONSTANT VOLUME HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#2, #12, #13, #14) (AUDITORIUM AND CAFETERIA)
- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air exhaust and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the hot water reheat valve will be fully open to the coil, the energy recovery wheel will be disabled, and the supply fan will be enabled to full speed. Unit will change to "occupied mode" when return air reaches 70°F (adjustable) or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan variable frequency drive and the energy recovery wheel. The variable frequency drive will index the supply fan to 100% of maximum cfm. The DDC Controller will modulate the Outside Air Damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station, closing the Return Air Damper a proportional amount. The DDC Controller will open the Exhaust Air Damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- D. The air-conditioning unit has four modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain space temperature at the setpoint of the DDC Controller.
 4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Outdoor Air Recovery Bypass Damper will be closed, the Exhaust Air Recovery Bypass Damper will be closed. The hot water valve will modulate open to maintain space temperature at the setpoint of the DDC Controller.
- E. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F.
- F. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the air-cooled condensing unit section and start the compressors. The supply fan VFD will maintain the fan at the 50% setting during dehumidification. Should the dehumidification process cause the space to over cool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- G. On a rise in space Carbon Dioxide to the setpoint of the DDC Controller, the DDC Controller will modulate the outside air damper between its minimum and maximum CO₂ damper position setpoints to maintain CO₂ setpoint.
- H. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- I. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- J. Whenever the unit is de-energized, the DDC Controller will modulate the preheat and reheat valves to maintain 55°F as sensed by the coil discharge sensors.



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Drawing Title

ROOF TOP UNIT 12 SEQUENCE OF OPERATION

Project Title

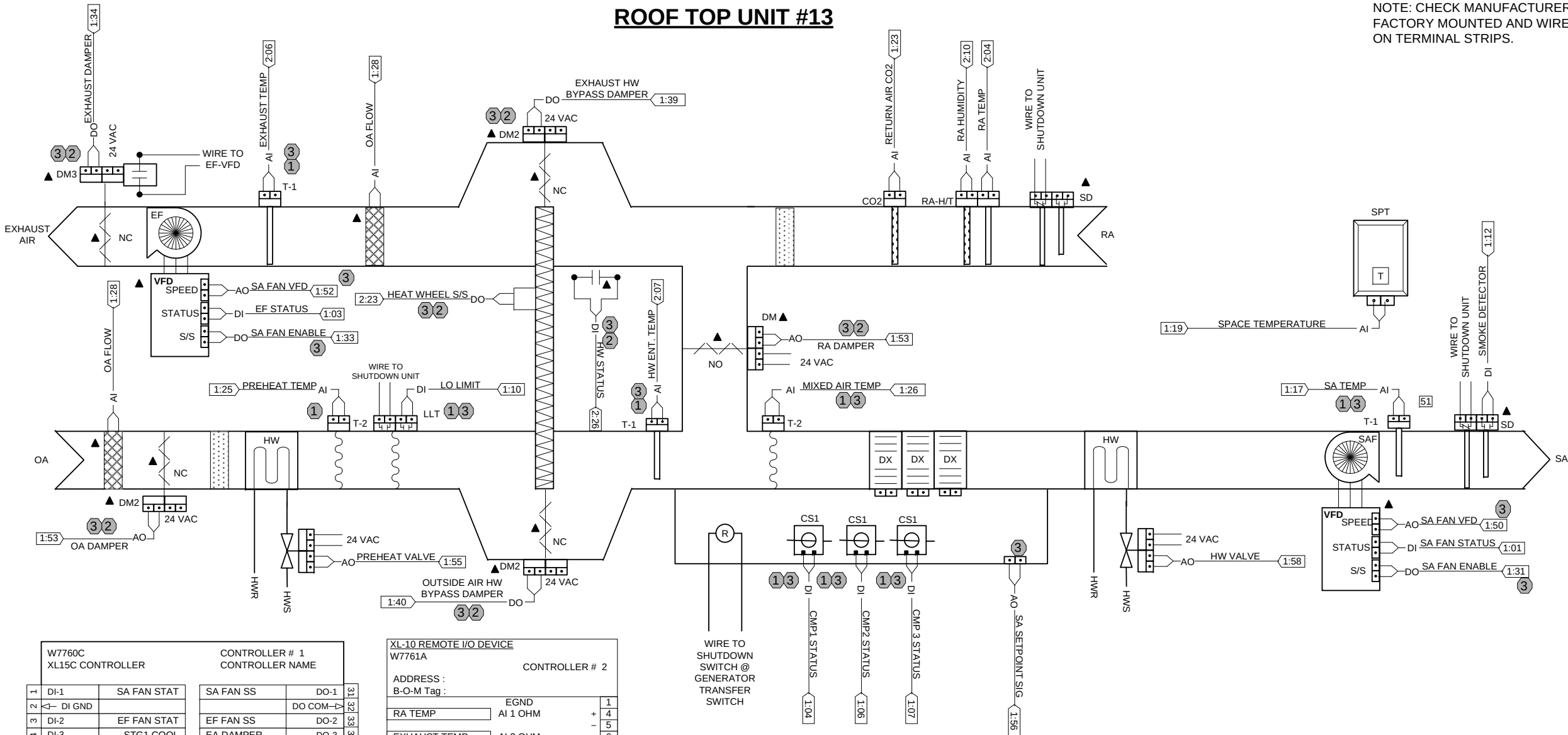
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA

		1	GENERATOR INTERLOCK			1/02/09	JBP
		1	TERMINATION CHANGES			12/19/07	JBP
REFERENCE DRAWING		NO.	REVISION-LOCATION			ECN	DATE
Sales Engineer	Project Manager	Application Engineer	DATE			APPROVED	
MH	JM	JP	BY	JP	DATE	06/08/07	BY
			Branch information			CONTRACT NUMBER	
CHESAPEAKE CONTROLS, INC. Systems & Services Division			1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781			0830-0134	
						DRAWING NUMBER	
						D-26	

ROOF TOP UNIT #13

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- 1 FACTORY MOUNTED DEVICE
 - 2 FACTORY PROVIDED AND MOUNTED DEVICE
 - 3 FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI-2	EF FAN STAT	32
3	DI-3	STG1 COOL	33
4	DI-4	STG2 COOL	34
5	DI-5	STG3 COOL	35
6	DI-6	LOW LIMIT	36
7	DI-7	SMOKE DET.	37
8	DI-8	LON	38
9	DI-9	LON	39
10	DI-10	LON	40
11	DI-11	LON	41
12	DI-12	LON	42
13	DI-13	LON	43
14	DI-14	LON	44
15	DI-15	LON	45
16	DI-16	LON	46
17	DI-17	LON	47
18	DI-18	LON	48
19	DI-19	LON	49
20	DI-20	LON	50
21	DI-21	LON	51
22	DI-22	LON	52
23	DI-23	LON	53
24	DI-24	LON	54
25	DI-25	LON	55
26	DI-26	LON	56
27	DI-27	LON	57
28	DI-28	LON	58
29	DI-29	LON	59
30	DI-30	LON	60

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :		B-O-M Tag :	
RA TEMP	EGND	1	1
EXHAUST TEMP	AI 1 OHM	4	4
HW ENT TEMP	AI 2 OHM	5	5
RA HUMIDITY	AI 3 OHM	6	6
	AI 4 OHM	7	7
	AI 5 V/mA	8	8
	AI 6 V/mA	9	9
	22 VDC OUT	10	10
	E-BUS (FTT)	11	11
	E-BUS (FTT)	12	12
	TRIAC 8	13	13
	TRIAC 7	14	14
	TRIAC 6	15	15
	TRIAC 5	16	16
	TRIAC 4	17	17
	TRIAC 3	18	18
	TRIAC 2	19	19
	TRIAC 1	20	20
	COM	21	21
	24 VAC IN	22	22
	DI 1	23	23
	DI 2	24	24
	DI 3	25	25
	DI 4	26	26

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-13 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	3
LLT	FREESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

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Drawing Title

**ROOF TOP UNIT 13
WIRING DIAGRAM**

Project Title

**MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA**

1	GENERATOR INTERLOCK	1/02/09	JBP		
2	ENGINEERING CHANGES	1/18/08	JBP		
1	TERMINATION CHANGES	12/19/07	JBP		
REFERENCE DRAWING	NO.	REVISION/LOCATION	ECN	DATE	BY
Sales Engineer	Project Manager	Application Engineer	DRAWN	APPROVED	
MH	JM	JP	BY JP	DATE 06/08/07	BY
Branch Information		CONTRACT NUMBER			
1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134			
Systems & Services Division		DRAWING NUMBER		D-27	

ROOF TOP UNIT #13 SEQUENCE OF OPERATION

4.2 CONSTANT VOLUME HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#2, #12, #13, #14)
 (AUDITORIUM AND CAFETERIA)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air exhaust and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the hot water reheat valve will be fully open to the coil, the energy recovery wheel will be disabled, and the supply fan will be enabled to full speed. Unit will change to "occupied mode" when return air reaches 70°F (adjustable) or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan variable frequency drive and the energy recovery wheel. The variable frequency drive will index the supply fan to 100% of maximum cfm. The DDC Controller will modulate the Outside Air Damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station, closing the Return Air Damper a proportional amount. The DDC Controller will open the Exhaust Air Damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- D. The air-conditioning unit has four modes of operation:

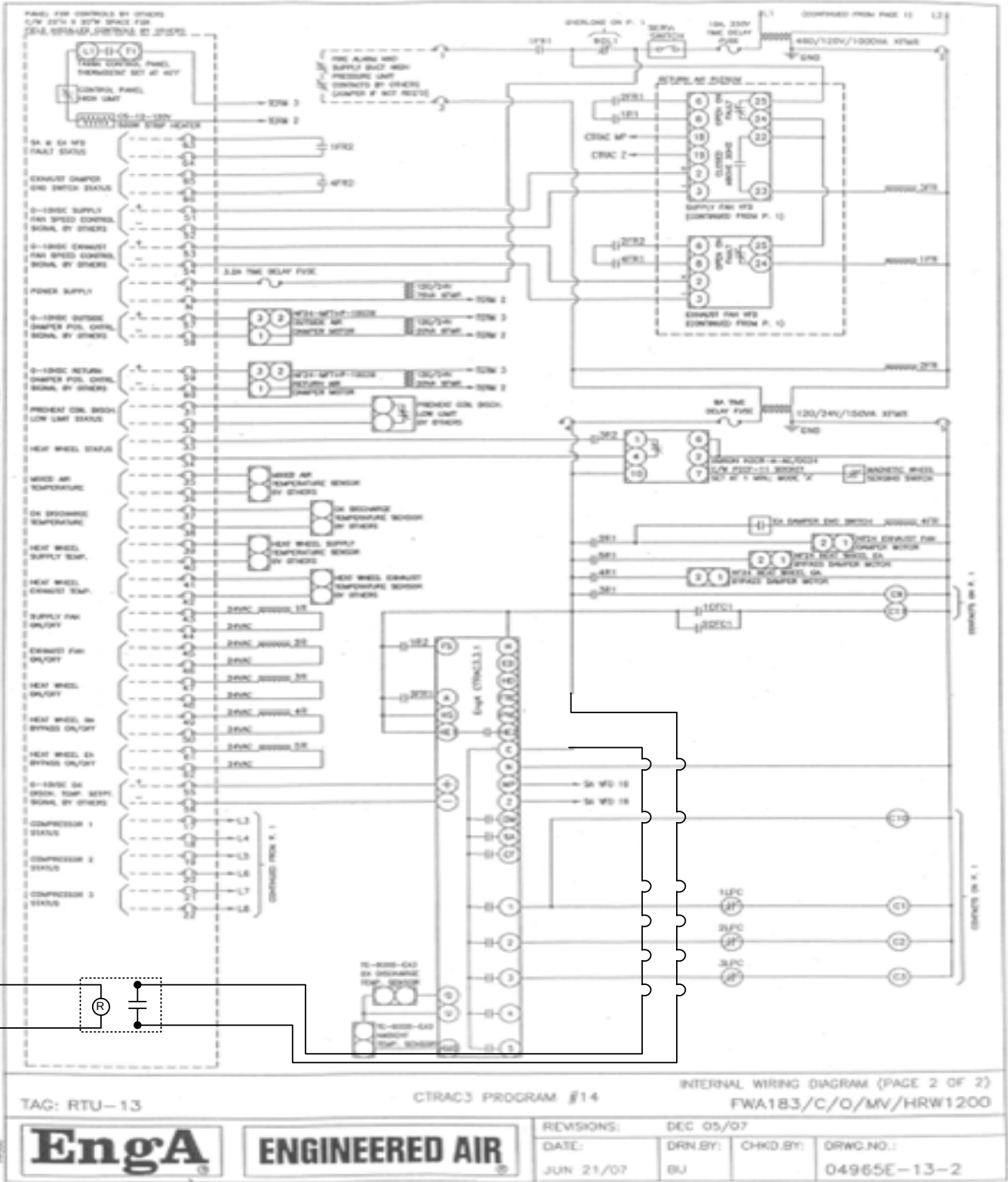
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.

2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.

3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain space temperature at the setpoint of the DDC Controller.

4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Outdoor Air Recovery Bypass Damper will be closed, the Exhaust Air Recovery Bypass Damper will be closed. The hot water valve will modulate open to maintain space temperature at the setpoint of the DDC Controller.
- E. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F.
- F. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the air-cooled condensing unit section and start the compressors. The supply fan VFD will maintain the fan at the 50% setting during dehumidification. Should the dehumidification process cause the space to over cool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- G. On a rise in space Carbon Dioxide to the setpoint of the DDC Controller, the DDC Controller will modulate the outside air damper between its minimum and maximum CO₂ damper position setpoints to maintain CO₂ setpoint.
- H. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- I. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- J. Whenever the unit is de-energized, the DDC Controller will modulate the preheat and reheat valves to maintain 55°F as sensed by the coil discharge sensors.

WIRE TO SHUTDOWN SWITCH @ GENERATOR TRANSFER SWITCH



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Drawing Title
ROOF TOP UNIT 13 SEQUENCE OF OPERATION

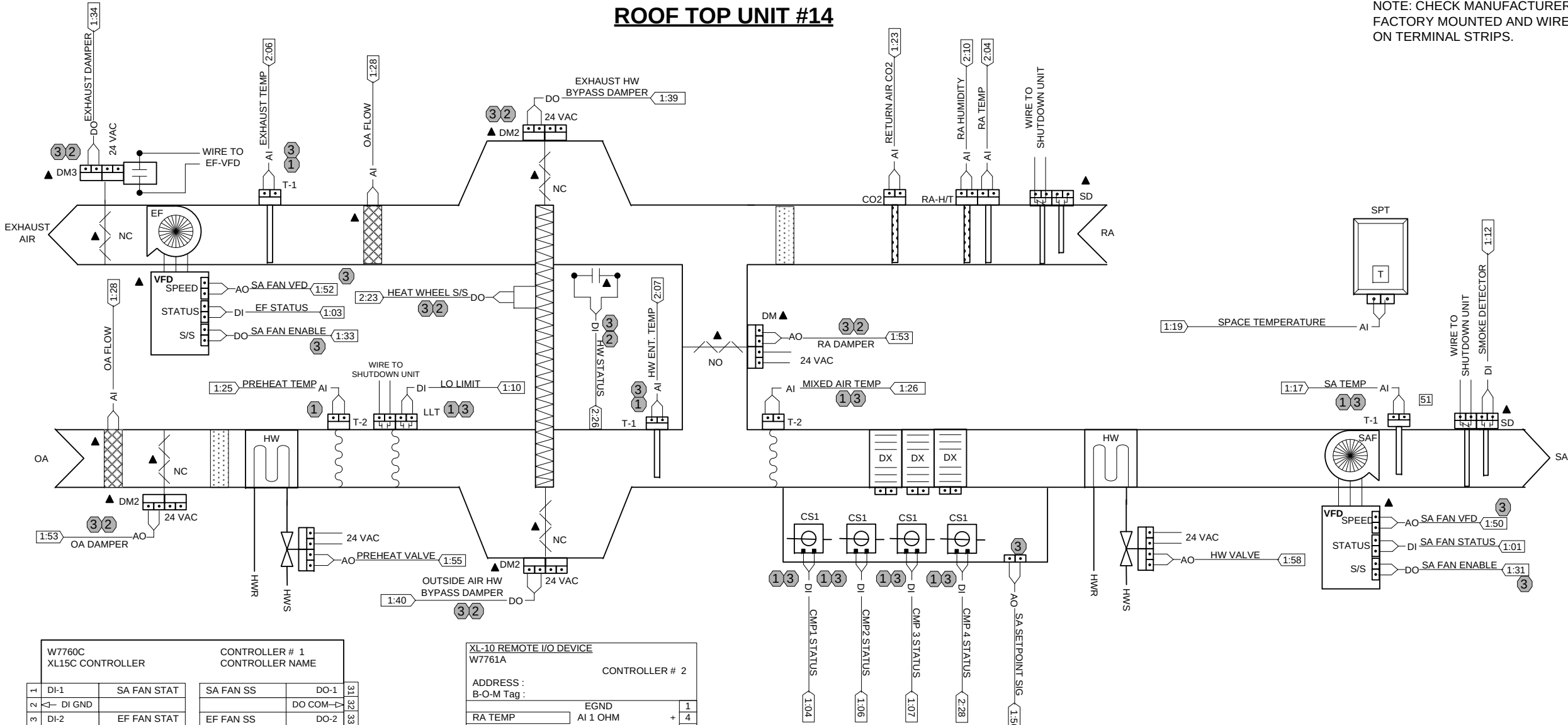
Project Title
 MENCHVILLE HIGH SCHOOL
 NEWPORT NEWS, VIRGINIA

1	GENERATOR INTERLOCK	1/02/09	JBP
1	TERMINATION CHANGES	12/19/07	JBP
REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN
SALES ENGINEER	PROJECT MANAGER	APPLICATION ENGINEER	DRAWN
MH	JM	JP	JP
DATE	DATE	DATE	DATE
06/08/07	06/08/07	06/08/07	06/08/07
Branch Information		CONTRACT NUMBER	
1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134	
Systems & Services Division		DRAWING NUMBER	
		D-28	

ROOF TOP UNIT #14

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- 1 FACTORY MOUNTED DEVICE
 - 2 FACTORY PROVIDED AND MOUNTED DEVICE
 - 3 FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI GND		32
3	DI-2	EF FAN STAT	33
4	DI-3	STG1 COOL	34
5	DI GND		35
6	DI-4	STG2 COOL	36
7	DI-5	STG3 COOL	37
8	DI GND		38
9	DI-6		39
10	DI-7	LOW LIMIT	40
11	DI GND		41
12	DI-8	SMOKE DET.	42
13	LON		43
14	LON		44
15	LON		45
16	LON		46
17	AI-1	SA TEMP	47
18	AI GND		48
19	AI-2	SPACE TEMP	49
20	AI-3		50
21	AI GND		51
22	AI-4	EA AIR FLOW	52
23	AI-5	RETURN CO2	53
24	AI GND		54
25	AI-6	PREHEAT TEM	55
26	AI-7	MA TEMP	56
27	AI GND		57
28	AI-8	AIR FLOW	58
29	GND		59
30	GND		60

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :			
B-O-M Tag :			
RA TEMP	AI 1 OHM	+	1
EXHAUST TEMP	AI 2 OHM	+	4
HW ENT TEMP	AI 3 OHM	+	5
	AI 4 OHM	+	6
RA HUMIDITY	AI 5 V/mA	+	7
	AI 6 V/mA	+	8
	22 VDC OUT	+	9
	E-BUS (FTT)	+	10
	E-BUS (FTT)	+	11
	TRIAC 8	+	12
	TRIAC 7	+	13
	TRIAC 6	+	14
	TRIAC 5	+	15
	TRIAC 4	+	16
	TRIAC 3	+	17
	TRIAC 2	+	18
HEAT WHEEL S/S	TRIAC 1	+	19
	COM	+	20
HEAT WHEEL	DI 1	+	21
STG4 COOL	DI 2	+	22
	DI 3	+	23
	DI 4	+	24

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-14 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
CS1	RELAY	VERIS	H-600	4
LLT	FREEZESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

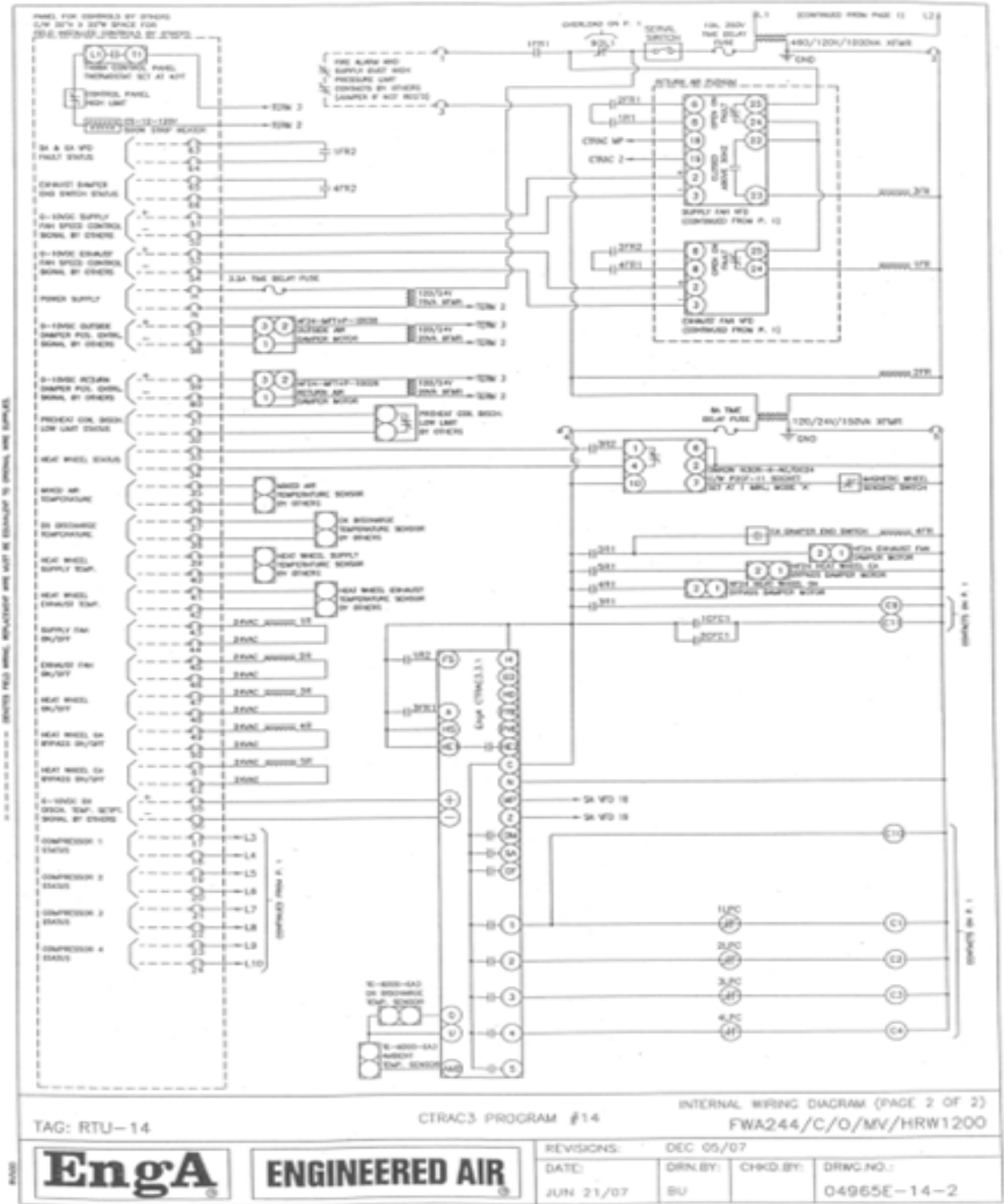
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Drawing Title		2		ENGINEERING CHANGES		1/18/08		JBP	
ROOF TOP UNIT 14 WIRING DIAGRAM		1		TERMINATION CHANGES		12/19/07		JBP	
Project Title		MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134		D-29	

ROOF TOP UNIT #14 SEQUENCE OF OPERATION

- 4.2 CONSTANT VOLUME HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#2, #12, #13, #14) (AUDITORIUM AND CAFETERIA)
- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air exhaust and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the hot water reheat valve will be fully open to the coil, the energy recovery wheel will be disabled, and the supply fan will be enabled to full speed. Unit will change to "occupied mode" when return air reaches 70°F (adjustable) or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan variable frequency drive and the energy recovery wheel. The variable frequency drive will index the supply fan to 100% of maximum cfm. The DDC Controller will modulate the Outside Air Damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station, closing the Return Air Damper a proportional amount. The DDC Controller will open the Exhaust Air Damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- D. The air-conditioning unit has four modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain space temperature at the setpoint of the DDC Controller.
 3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain space temperature at the setpoint of the DDC Controller.
 4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Outdoor Air Recovery Bypass Damper will be closed, the Exhaust Air Recovery Bypass Damper will be closed. The hot water valve will modulate open to maintain space temperature at the setpoint of the DDC Controller.
- E. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F.
- F. On a rise in return humidity to the setpoint of the DDC Controller, the DDC Controller will energize the air-cooled condensing unit section and start the compressors. The supply fan VFD will maintain the fan at the 50% setting during dehumidification. Should the dehumidification process cause the space to over cool, the DDC Controller will modulate the heating coil valve open to maintain space heating setpoint.
- G. On a rise in space Carbon Dioxide to the setpoint of the DDC Controller, the DDC Controller will modulate the outside air damper between its minimum and maximum CO₂ damper position setpoints to maintain CO₂ setpoint.
- H. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- I. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- J. Whenever the unit is de-energized, the DDC Controller will modulate the preheat and reheat valves to maintain 55°F as sensed by the coil discharge sensors.



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Drawing Title
**ROOF TOP UNIT 14
SEQUENCE OF OPERATION**

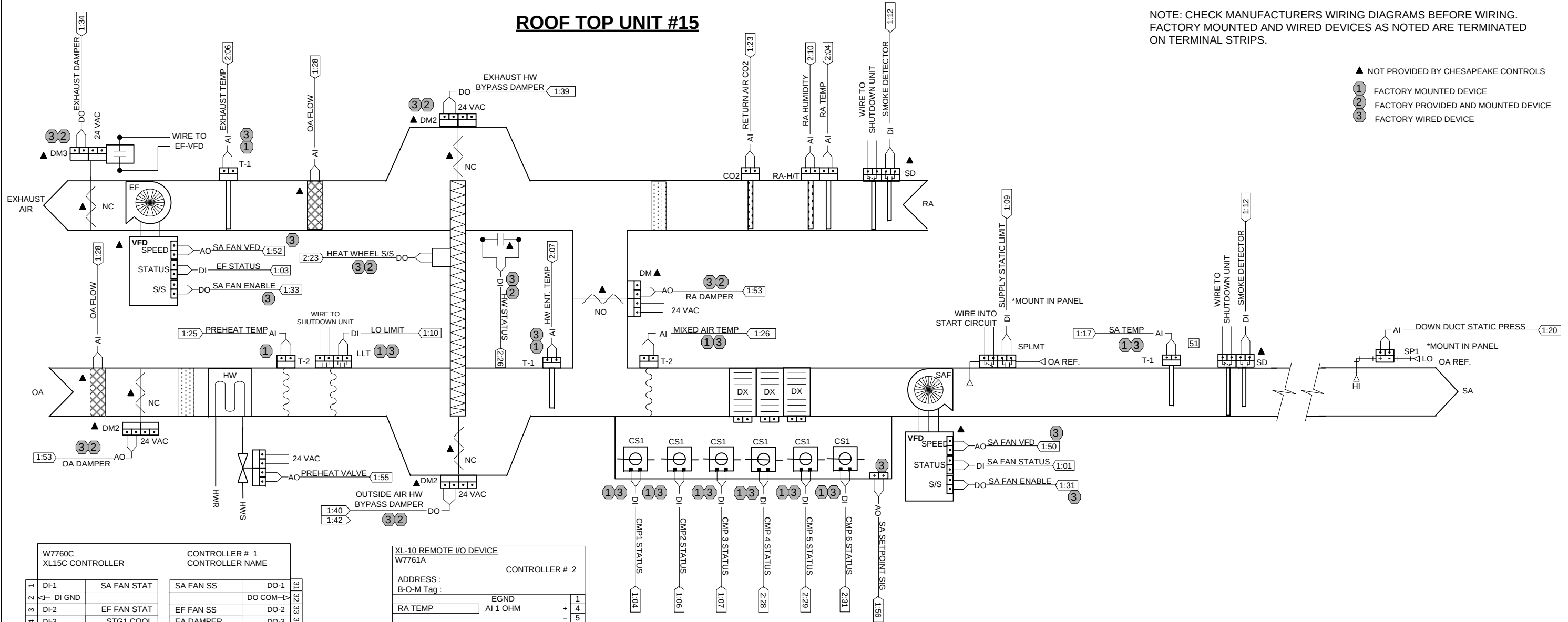
Project Title
**MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA**

1		TERMINATION CHANGES		12/19/07	JBP
REFERENCE DRAWING	NO.	REVISION-LOCATION		ECN	DATE
Sales Engineer	Project Manager	Application Engineer		APPROVED	
MH	JM	JP		BY	DATE
DATE		06/08/07		DATE	
Branch Information		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		CONTRACT NUMBER 0830-0134	
Systems & Services Division		DRAWING NUMBER D-30			

ROOF TOP UNIT #15

NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- 1 FACTORY MOUNTED DEVICE
2 FACTORY PROVIDED AND MOUNTED DEVICE
3 FACTORY WIRED DEVICE



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI GND		32
3	DI-2	EF FAN STAT	33
4	DI-3	STG1 COOL	34
5	DI GND		35
6	DI-4	STG2 COOL	36
7	DI-5	STG3 COOL	37
8	DI GND		38
9	DI-6	HI STATIC LMT	39
10	DI-7	LOW LIMIT	40
11	DI GND		41
12	DI-8	SMOKE DET.	42
13	LON		43
14	LON		44
15	LON		45
16	LON		46
17	AI-1	SA TEMP	47
18	AI GND		48
19	AI-2		49
20	AI-3	DUCT STATIC	50
21	AI GND		51
22	AI-4	EA AIR FLOW	52
23	AI-5	RETURN CO2	53
24	AI GND		54
25	AI-6	PREHEAT TEM	55
26	AI-7	MA TEMP	56
27	AI GND		57
28	AI-8	AIR FLOW	58
29	GND		59
30	GND		60

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :			
B-O-M Tag :			
RA TEMP	AI 1 OHM	1	1
EXHAUST TEMP	AI 2 OHM	2	2
HW ENT TEMP	AI 3 OHM	3	3
	AI 4 OHM	4	4
RA HUMIDITY	AI 5 V/mA	5	5
	AI 6 V/mA	6	6
	22 VDC OUT	7	7
	E-BUS (FTT)	8	8
	E-BUS (FTT)	9	9
	TRIAC 8	10	10
	TRIAC 7	11	11
	TRIAC 6	12	12
	TRIAC 5	13	13
	TRIAC 4	14	14
	TRIAC 3	15	15
	TRIAC 2	16	16
HEAT WHEEL S/S	TRIAC 1	17	17
	COM	18	18
HEAT WHEEL	DI 1	19	19
STG4 COOL	DI 2	20	20
STG5 COOL	DI 3	21	21
STG6 COOL	DI 4	22	22

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-15 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
SP1	PRESSURE TRANSMITTER	VERIS	PXPLX02S	1
SPLMT	STATIC PRRESSURE HI LIMIT	DYNACON	AFS-460-DSS	1
CS1	RELAY	VERIS	H-600	6
LLT	FREEZESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

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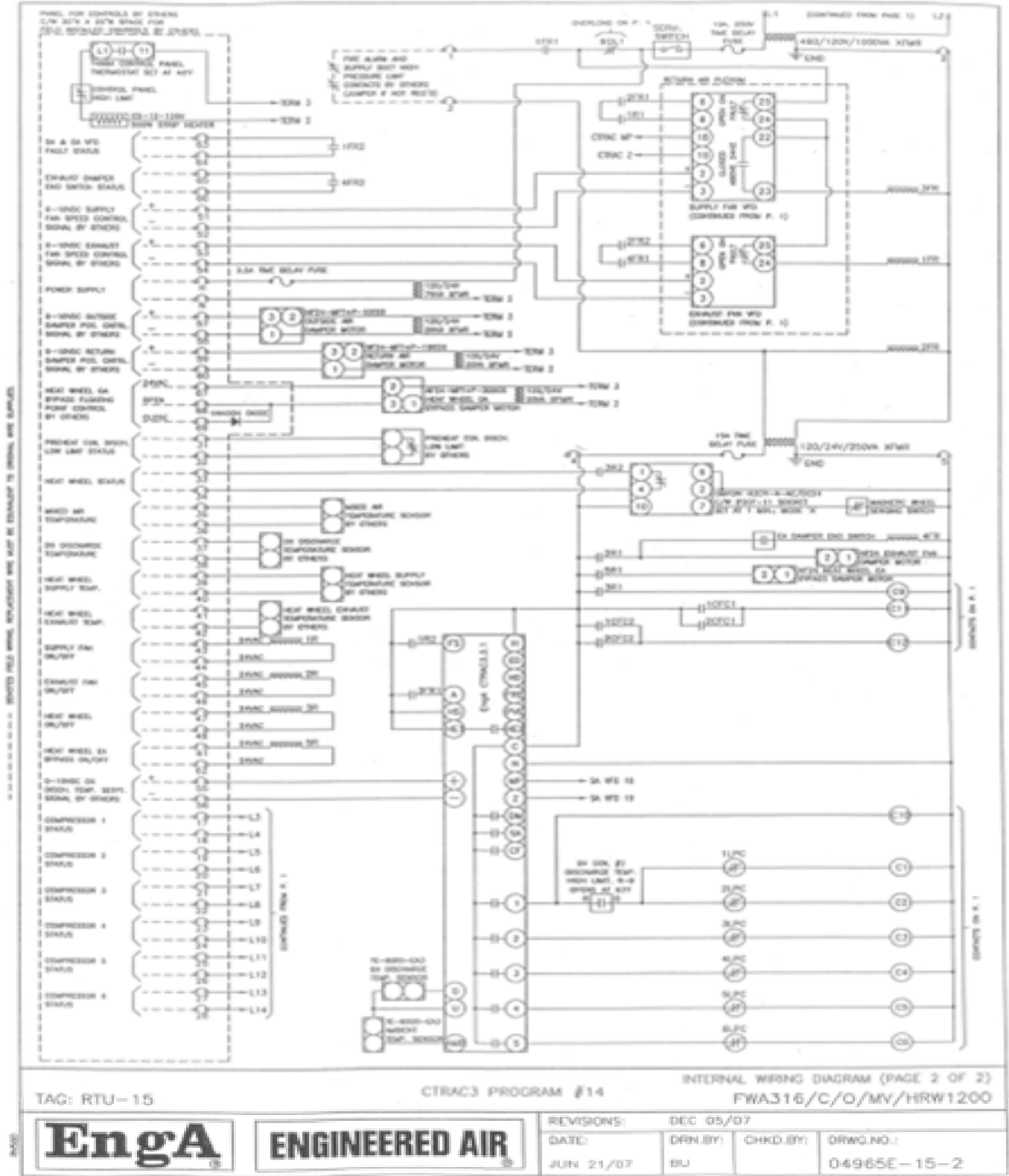
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Drawing Title		2		ENGINEERING CHANGES		1/18/08		JBP	
ROOF TOP UNIT 15 WIRING DIAGRAM		1		TERMINATION CHANGES		12/19/07		JBP	
Project Title		MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		REFERENCE DRAWING		NO.		REVISION-LOCATION	
				Sales Engineer		Project Manager		Application Engineer	
				MH		JM		JP	
				BY		DATE		06/08/07	
				Branch Information		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		CONTRACT NUMBER	
				CHESAPEAKE CONTROLS, INC.		Systems & Services Division		0830-0134	
								DRAWING NUMBER	
								D-31	

ROOF TOP UNIT #15 SEQUENCE OF OPERATION

VARIABLE AIR VOLUME, HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#1, #10, #11, #15, #16, #17) CONTROL (CLASSROOMS AND ADMINISTRATION/MEDIA CENTER)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air, exhaust, and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the energy recovery wheel will be disabled, and the supply fan will be enabled. Unit supply air temperature will be reset upward to 80°F (adjustable). Unit will change to “occupied mode” when return air temperature reaches 70°F (adjustable), or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan and the energy recovery wheel. The DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station closing the return air damper a proportional amount. The DDC Controller will open the exhaust air damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. Supply fan speed will be controlled to maintain down duct supply air static pressure setpoint. System will monitor the primary air valve position on all terminal variable air volume boxes and reset the supply duct static pressure setpoint so that at least one terminal VAV boxes primary air valve is at least 95% open. If the discharge static pressure rises above the static high-pressure setpoint, (4” wc adjustable) supply fan will be disabled. Manual reset will be required to restart unit.
- D. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- E. The air-conditioning unit has four modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain the discharge air temperature (50°F adjustable). The discharge air temperature will be reset from the space having the highest cooling demand.
 4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the mixed air temperature is below the discharge air temperature setpoint (50°F adjustable), the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper, and the Outside Air Recovery Bypass Damper will be closed. The preheat valve will modulate open to maintain discharge air temperature of 50°F (adjustable) setpoint of the DDC Controller.
- F. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge air temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F. If the temperature, measured downstream of the heat recovery wheel, rises above the unit discharge air temperature setpoint, then the Outside Air Recovery Bypass Damper shall modulate open to bypass the preheated air around the heat recovery wheel.
- G. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- H. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- I. Whenever the unit is de-energized, the DDC Controller will modulate the preheat valve to maintain 50°F as sensed by the preheat coil discharge sensor.
- J. The mechanical cooling will be locked out if the supply fan cfm falls below 40% of maximum. The fan rpm that results in this cfm value shall be determined during the unit fan balancing.

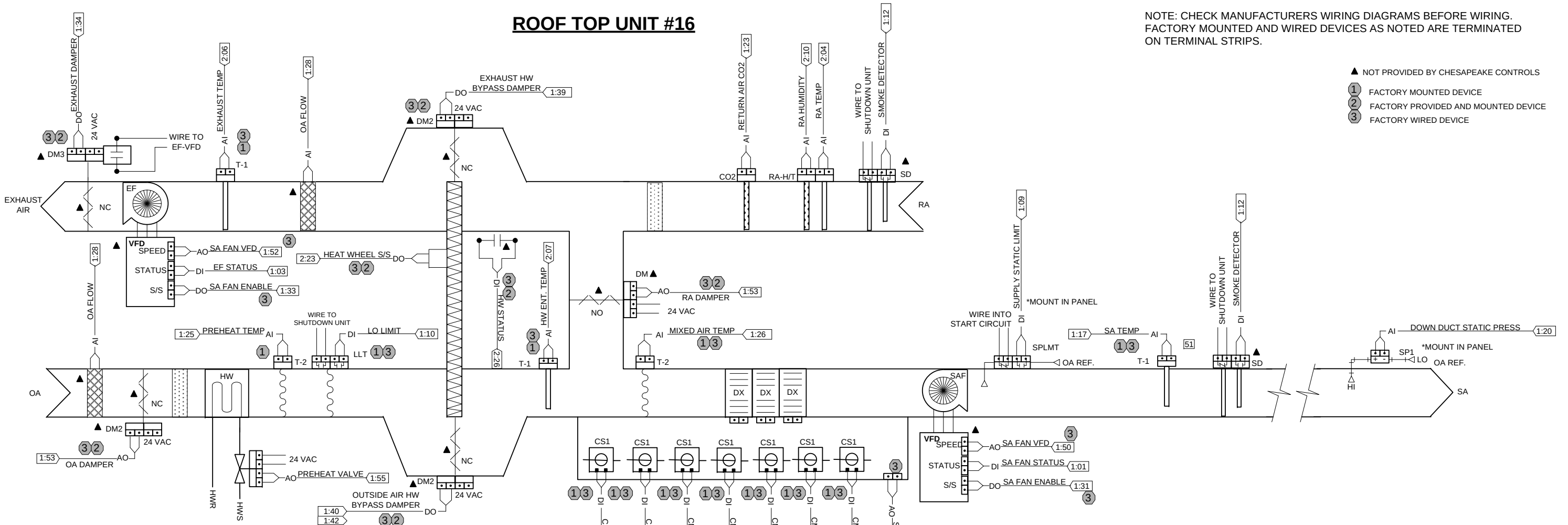


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Drawing Title										
ROOF TOP UNIT 15 SEQUENCE OF OPERATION										
			1	TERMINATION CHANGES					12/19/07	JBP
		REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN	DATE	BY
Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED		
MH		JM		JP		BY JP DATE 06/08/07		BY DATE		
Project Title		CHESAPEAKE CONTROLS, INC. Systems & Services Division				Branch Information		CONTRACT NUMBER		
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA						1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134		
								DRAWING NUMBER		
								D-32		

ROOF TOP UNIT #16



W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	DO-1
2	DI-1 GND		DO COM
3	DI-2	EF FAN STAT	DO-2
4	DI-3	STG1 COOL	DO-3
5	DI-1 GND		DO COM
6	DI-4	STG2 COOL	DO-4
7	DI-5	STG3 COOL	DO-5
8	DI-1 GND		DO COM
9	DI-6	HI STATIC LMT	DO-6
10	DI-7	LOW LIMIT	DO-7
11	DI-1 GND		DO COM
12	DI-8	SMOKE DET.	DO-8
13	LON		20 VDC
14	LON		VDC COM
15	LON		24 VAC (RETURN)
16	LON		24 VAC (LINE)
17	AI-1	SA TEMP	E-GND
18	AI-1 GND		SA FAN SPEED
19	AI-2		AO-1
20	AI-3	DUCT STATIC	AO COM
21	AI-1 GND		AO-2
22	AI-4	EA AIR FLOW	AO-3
23	AI-5	RETURN CO2	AO-4
24	AI-1 GND		AO-5
25	AI-6	PREHEAT TEM	AO-6
26	AI-7	MA TEMP	
27	AI-1 GND		
28	AI-8	AIR FLOW	
29	GND		
30	GND		

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :			
B-O-M Tag :			
RA TEMP	AI 1 OHM	EGND	1
EXHAUST TEMP	AI 2 OHM		4
HW ENT TEMP	AI 3 OHM		5
STG7 COOL	AI 4 OHM		6
RA HUMIDITY	AI 5 V/mA		7
	AI 6 V/mA		8
	22 VDC OUT		9
	E-BUS (FTT)		10
	E-BUS (FTT)		11
	TRIAC 8		12
	TRIAC 7		13
	TRIAC 6		14
	TRIAC 5		15
	TRIAC 4		16
	TRIAC 3		17
	TRIAC 2		18
HEAT WHEEL S/S	TRIAC 1		19
	COM		20
HEAT WHEEL	DI 1		21
STG4 COOL	DI 2		22
STG5 COOL	DI 3		23
STG6 COOL	DI 4		24

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

RTU-16 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
SP1	PRESSURE TRANSMITTER	VERIS	PXPLX02S	1
SPLM T	STATIC PRRESSURE HI LIMIT	DYNACON	AFS-460-DSS	1
CS1	RELAY	VERIS	H-600	7
LLT	FREEZESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

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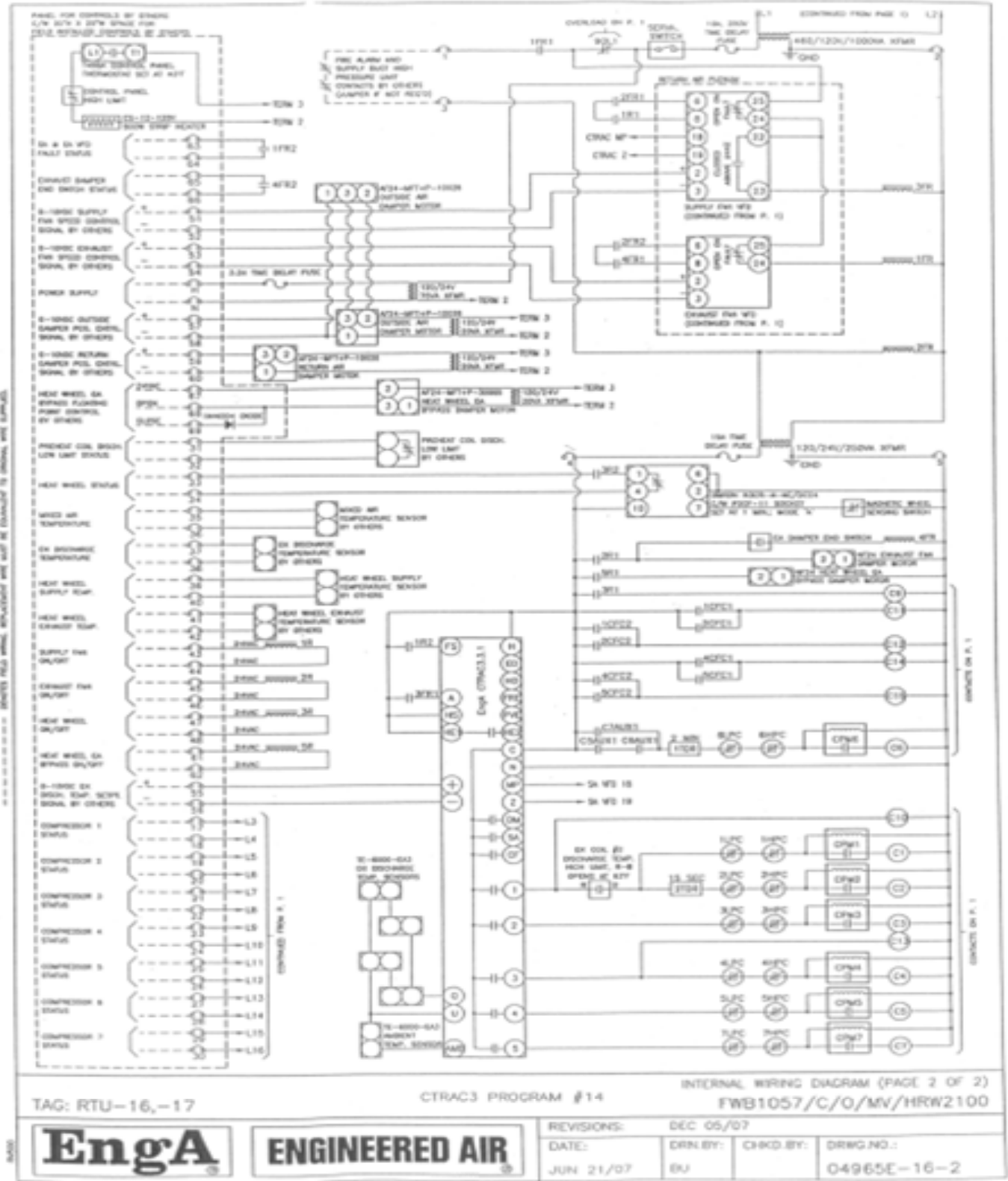
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Drawing Title		2		ENGINEERING CHANGES		1/18/08		JBP	
ROOF TOP UNIT 16 WIRING DIAGRAM		1		TERMINATION CHANGES		12/19/07		JBP	
Project Title		MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		Branch Information		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		CONTRACT NUMBER	
				CHESAPEAKE CONTROLS, INC.		Systems & Services Division		DRAWING NUMBER	
								0830-0134	
								D-33	

ROOF TOP UNIT #16 SEQUENCE OF OPERATION

VARIABLE AIR VOLUME, HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#1, #10, #11, #15, #16, #17)
CONTROL (CLASSROOMS AND ADMINISTRATION/MEDIA CENTER)

- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air, exhaust, and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the energy recovery wheel will be disabled, and the supply fan will be enabled. Unit supply air temperature will be reset upward to 80°F (adjustable). Unit will change to “occupied mode” when return air temperature reaches 70°F (adjustable), or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan and the energy recovery wheel. The DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station closing the return air damper a proportional amount. The DDC Controller will open the exhaust air damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. Supply fan speed will be controlled to maintain down duct supply air static pressure setpoint. System will monitor the primary air valve position on all terminal variable air volume boxes and reset the supply duct static pressure setpoint so that at least one terminal VAV boxes primary air valve is at least 95% open. If the discharge static pressure rises above the static high-pressure setpoint, (4” wc adjustable) supply fan will be disabled. Manual reset will be required to restart unit.
- D. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- E. The air-conditioning unit has four modes of operation:
1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.
 3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain the discharge air temperature (50°F adjustable). The discharge air temperature will be reset from the space having the highest cooling demand.
 4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the mixed air temperature is below the discharge air temperature setpoint (50°F adjustable), the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper, and the Outside Air Recovery Bypass Damper will be closed. The preheat valve will modulate open to maintain discharge air temperature of 50°F (adjustable) setpoint of the DDC Controller.
- F. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge air temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F. If the temperature, measured downstream of the heat recovery wheel, rises above the unit discharge air temperature setpoint, then the Outside Air Recovery Bypass Damper shall modulate open to bypass the preheated air around the heat recovery wheel.
- G. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- H. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- I. Whenever the unit is de-energized, the DDC Controller will modulate the preheat valve to maintain 50°F as sensed by the preheat coil discharge sensor.
- J. The mechanical cooling will be locked out if the supply fan cfm falls below 40% of maximum. The fan rpm that results in this cfm value shall be determined during the unit fan balancing.

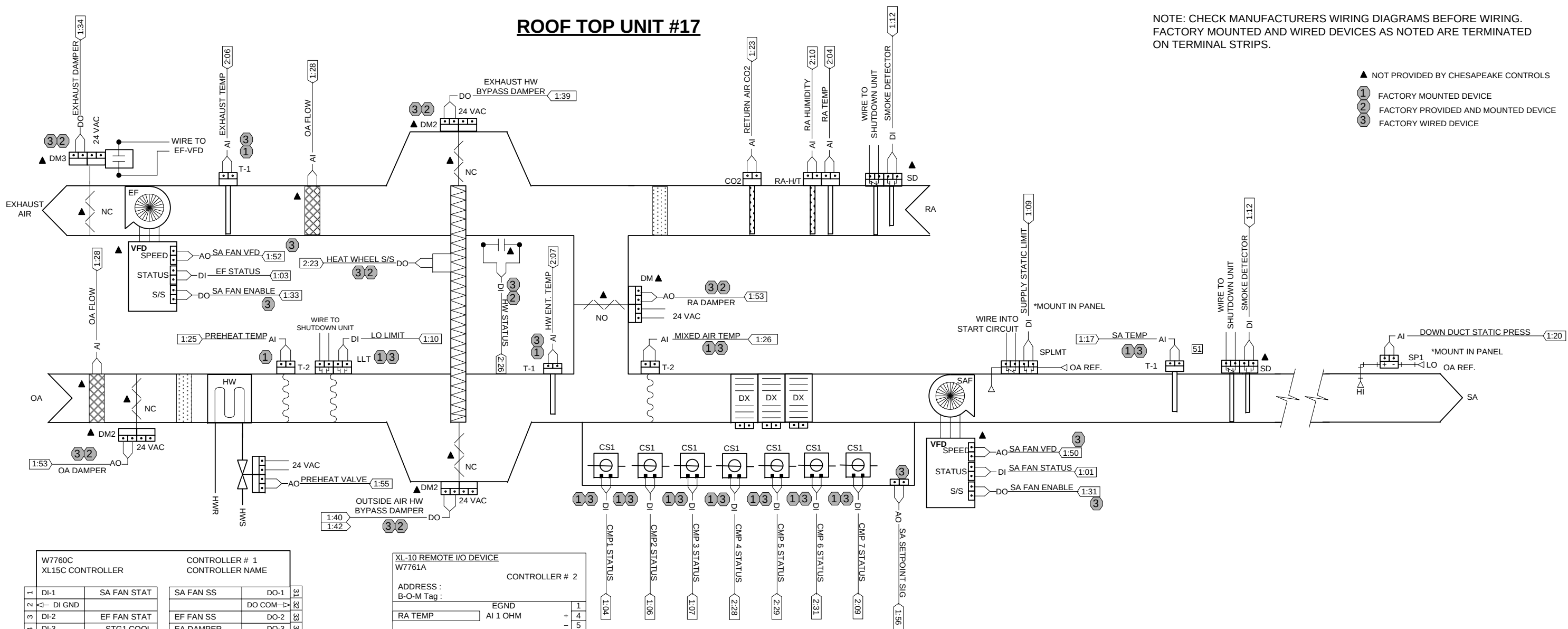


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Drawing Title									
ROOF TOP UNIT 16 SEQUENCE OF OPERATION									
			1	TERMINATION CHANGES				12/19/07	JBP
		REFERENCE DRAWING		NO.	REVISION-LOCATION		ECN	DATE	BY
Sales Engineer		Project Manager	Application Engineer		DRAWN		APPROVED		
MH		JM	JP		BY JP	DATE 06/08/07	BY	DATE	
Project Title		CHESAPEAKE CONTROLS, INC. Systems & Services Division				Branch Information		CONTRACT NUMBER	
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA						1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134	
								DRAWING NUMBER	
								D-34	

ROOF TOP UNIT #17



NOTE: CHECK MANUFACTURERS WIRING DIAGRAMS BEFORE WIRING.
FACTORY MOUNTED AND WIRED DEVICES AS NOTED ARE TERMINATED
ON TERMINAL STRIPS.

- ▲ NOT PROVIDED BY CHESAPEAKE CONTROLS
- 1 FACTORY MOUNTED DEVICE
2 FACTORY PROVIDED AND MOUNTED DEVICE
3 FACTORY WIRED DEVICE

*SEE NEXT PAGE FOR SEQUENCE OF OPERATION

W7760C XL15C CONTROLLER		CONTROLLER # 1 CONTROLLER NAME	
1	DI-1	SA FAN STAT	31
2	DI-2	EF FAN STAT	32
3	DI-3	STG1 COOL	33
4	DI-4	STG2 COOL	34
5	DI-5	STG3 COOL	35
6	DI-6	HI STATIC LMT	36
7	DI-7	LOW LIMIT	37
8	DI-8	SMOKE DET.	38
9	LON		39
10	LON		40
11	AI-1	SA TEMP	41
12	AI-2	DUCT STATIC	42
13	AI-3	EA AIR FLOW	43
14	AI-4	RETURN CO2	44
15	AI-5	PREHEAT TEM	45
16	AI-6	MA TEMP	46
17	AI-7	AIR FLOW	47
18	AI-8		48
19	GND		49
20	GND		50

XL-10 REMOTE I/O DEVICE W7761A		CONTROLLER # 2	
ADDRESS :	EGND	1	
B-O-M Tag :	RA TEMP	2	
	EXHAUST TEMP	3	
	HW ENT TEMP	4	
	STG7 COOL	5	
	RA HUMIDITY	6	
	AI 6 V/mA	7	
	22 VDC OUT	8	
	E-BUS (FTT)	9	
	E-BUS (FTT)	10	
	TRIAC 8	11	
	TRIAC 7	12	
	TRIAC 6	13	
	TRIAC 5	14	
	TRIAC 4	15	
	TRIAC 3	16	
	TRIAC 2	17	
	HEAT WHEEL S/S	18	
	COM	19	
	24 VAC IN	20	
	HEAT WHEEL	21	
	STG4 COOL	22	
	STG5 COOL	23	
	STG6 COOL	24	

RTU-17 Bill of Materials

DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
DDC1	DDC CONTROLLER	HONEYWELL	W7760C2017	1
DDC2	DDC CONTROLLER	HONEYWELL	W7761A2010	1
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	3
T2	AVERAGING DUCT SENSOR	HONEYWELL	C7041J2007	2
RA-H/T	RH/T, ECONOMY, DUCT, 3%	VERIS	HED3M STM	1
CO2	CO2, DUCT, ECONOMY	VERIS	CDE	1
SP1	PRESSURE TRANSMITTER	VERIS	PXPLX02S	1
SPLMT	STATIC PRRESSURE HI LIMIT	DYNACON	AFS-460-DSS	1
CS1	RELAY	VERIS	H-600	7
LLT	FREEZESTAT	DYNACON	FS-50	1
V1	SEE VALVE SCHEDULE			

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Drawing Title

ROOF TOP UNIT 17
WIRING DIAGRAM

Project Title

MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA

2		ENGINEERING CHANGES		1/18/08	JBP
1		TERMINATION CHANGES		12/19/07	JBP
REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY
Sales Engineer	Project Manager	Application Engineer	DRAWN	APPROVED	
MH	JM	JP	BY JP	DATE 06/08/07	BY DATE
Branch Information		CONTRACT NUMBER		DRAWING NUMBER	
1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134		D-35	

ROOF TOP UNIT #17 SEQUENCE OF OPERATION

VARIABLE AIR VOLUME, HEAT RECOVERY ROOFTOP AIR-CONDITIONING UNITS (#1, #10, #11, #15, #16, #17) CONTROL (CLASSROOMS AND ADMINISTRATION/MEDIA CENTER)

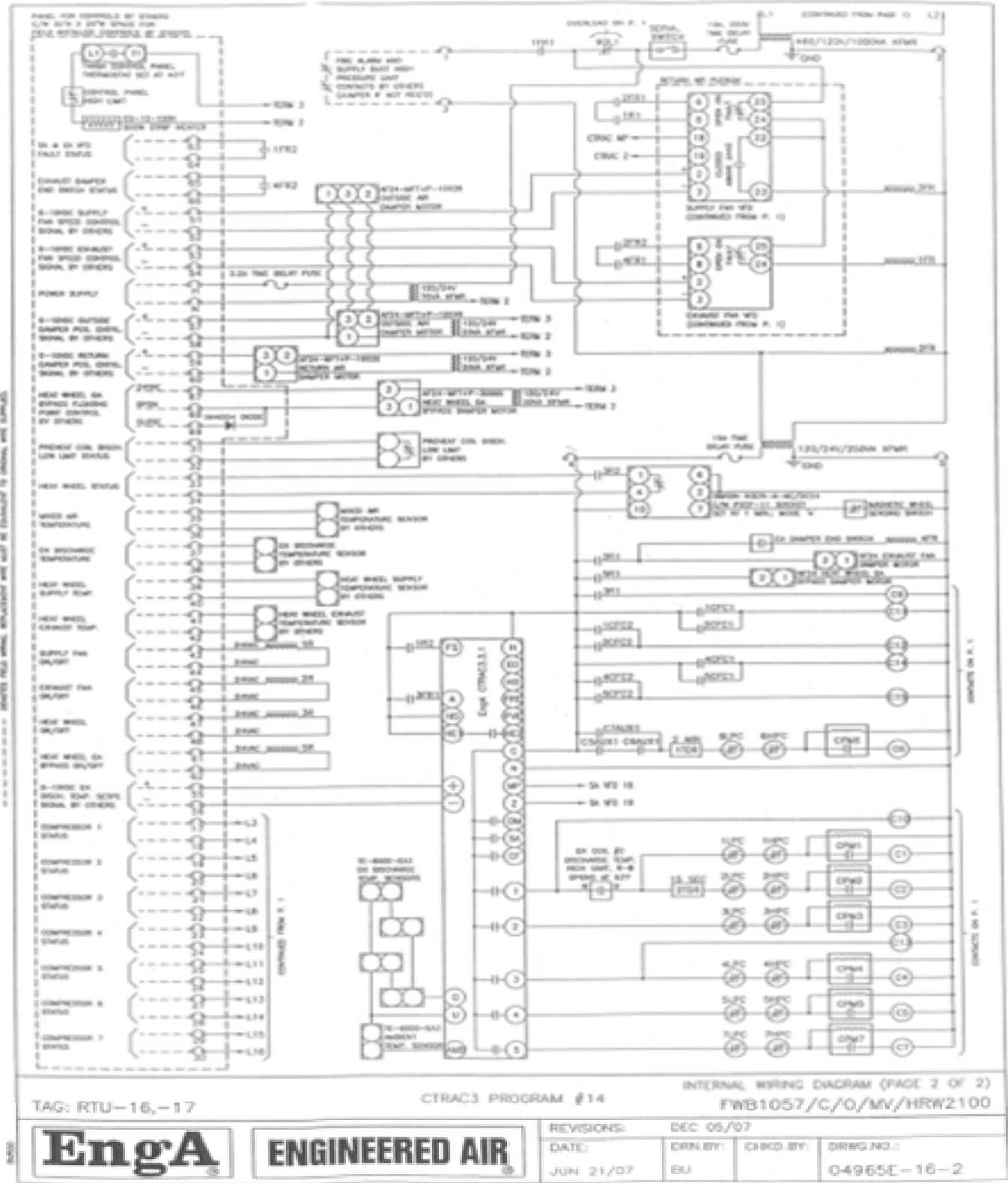
- A. The DDC Controller will energize the unit through its optimization program for morning warm-up. During morning warm-up, the outside air, exhaust, and recovery bypass dampers will remain fully closed, the return air damper will be fully open, the energy recovery wheel will be disabled, and the supply fan will be enabled. Unit supply air temperature will be reset upward to 80°F (adjustable). Unit will change to "occupied mode" when return air temperature reaches 70°F (adjustable), or when scheduled by the DDC.
- B. At occupancy time, the DDC Controller will enable the supply air fan and the energy recovery wheel. The DDC Controller will modulate the outside air damper open to maintain its preset minimum airflow setpoint as sensed by the airflow monitoring station closing the return air damper a proportional amount. The DDC Controller will open the exhaust air damper. The exhaust air damper end switch will enable the exhaust fan variable frequency drive. The recovery bypass dampers will remain closed.
- C. Supply fan speed will be controlled to maintain down duct supply air static pressure setpoint. System will monitor the primary air valve position on all terminal variable air volume boxes and reset the supply duct static pressure setpoint so that at least one terminal VAV boxes primary air valve is at least 95% open. If the discharge static pressure rises above the static high-pressure setpoint, (4" wc adjustable) supply fan will be disabled. Manual reset will be required to restart unit.
- D. The exhaust air fan VFD will be controlled by the OA AFMS to maintain a fixed cfm differential between the OA cfm and the exhaust air cfm (90%).
- E. The air-conditioning unit has four modes of operation:

1. Cooling Recovery: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint and the return air temperature. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper and the Outside Air Recovery Bypass Damper will be closed. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.

2. Cooling No Recovery Mode: This mode is enabled when the outside air temperature is above the outside air dry-bulb economizing enable setpoint but below 70°F. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. The air-cooled condensing unit section compressors will cycle to maintain the discharge air temperature setpoint (50°F adjustable). The discharge air setpoint will be inversely reset from space temperature.

3. Cooling Economizer Mode: This mode is enabled when the outside air temperature is below the outside air-dry bulb economizing enable setpoint and below the return air temperature. In this mode, the heat wheel will be disabled, the Exhaust Air Recovery Bypass Damper will be 100% open, and the Outside Air Recovery Bypass Damper will be 100% open. When the economizer mode is enabled, the Outside Air Damper will modulate between its minimum flow setpoint and its maximum flow setpoint, closing the Return Air Damper a proportional amount to maintain the discharge air temperature (50°F adjustable). The discharge air temperature will be reset from the space having the highest cooling demand.

4. Heating Recovery Mode: This mode is enabled when the outside air temperature is below the outside air dry-bulb economizing enable setpoint, the mixed air temperature is below the discharge air temperature setpoint (50°F adjustable), the air-cooled condensing unit is de-energized, and the outside airflow is at the minimum flow setting. In this mode, the heat wheel will be enabled, the Exhaust Air Recovery Bypass Damper, and the Outside Air Recovery Bypass Damper will be closed. The preheat valve will modulate open to maintain discharge air temperature of 50°F (adjustable) setpoint of the DDC Controller.
- F. Preheat Coil Freeze Protection Mode: When the outside air temperature drops below 40°F, the preheat valve will modulate open to maintain flow through the coil. The preheat discharge air temperature, measured upstream of the heat recovery wheel, will be maintained at 40°F. If the temperature, measured downstream of the heat recovery wheel, rises above the unit discharge air temperature setpoint, then the Outside Air Recovery Bypass Damper shall modulate open to bypass the preheated air around the heat recovery wheel.
- G. Whenever the setting of the freezestat is reached, the freezestat will de-energize the supply air fan, exhaust air fan, and close the outside air damper.
- H. On detection of products of combustion, the smoke detector will stop the unit supply air fan, exhaust air fan, and close the outside air damper.
- I. Whenever the unit is de-energized, the DDC Controller will modulate the preheat valve to maintain 50°F as sensed by the preheat coil discharge sensor.
- J. The mechanical cooling will be locked out if the supply fan cfm falls below 40% of maximum. The fan rpm that results in this cfm value shall be determined during the unit fan balancing.



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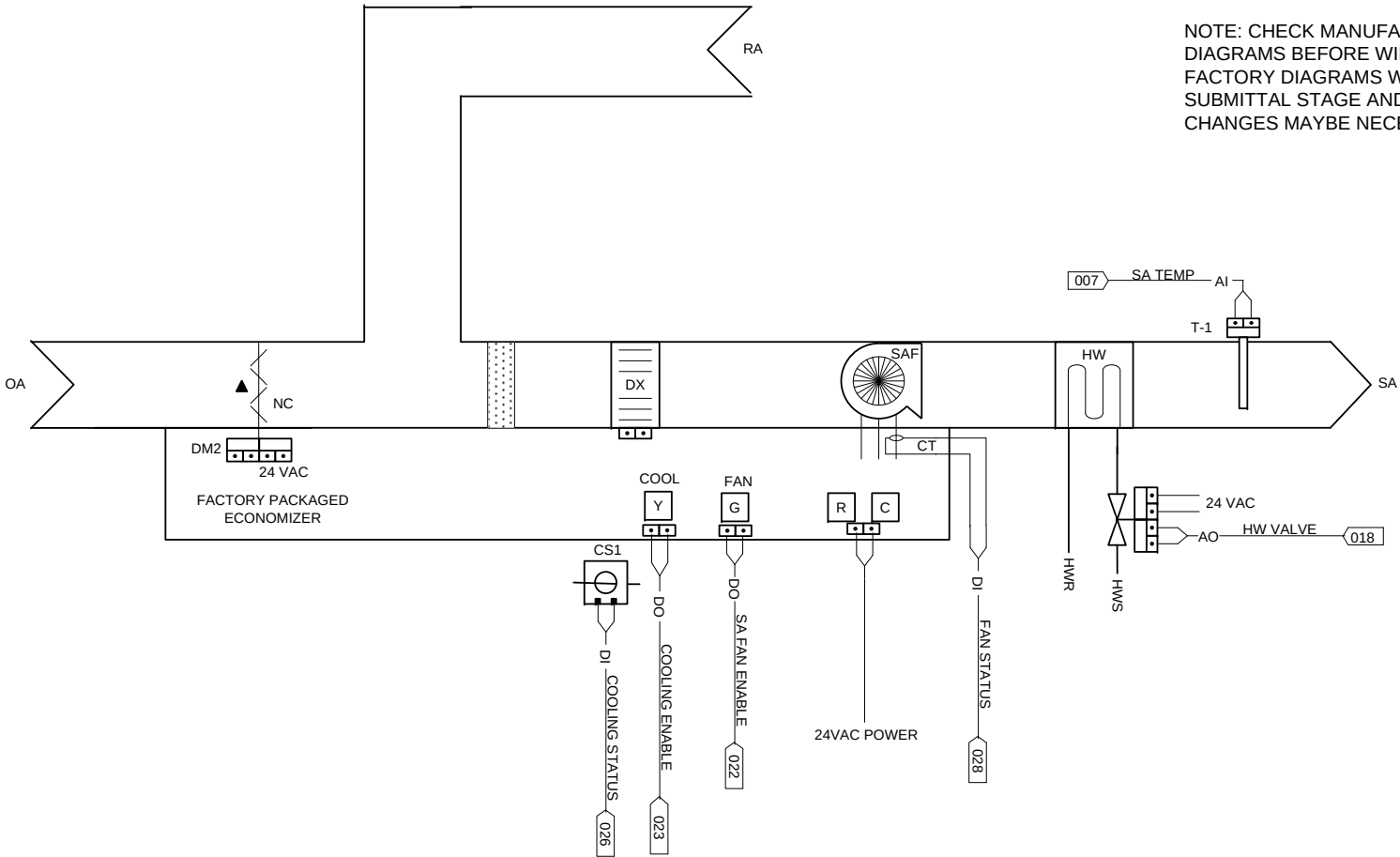
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Drawing Title									
ROOF TOP UNIT 17 SEQUENCE OF OPERATION									
			1	TERMINATION CHANGES				12/19/07	JBP
		REFERENCE DRAWING		NO.	REVISION-LOCATION		ECN	DATE	BY
Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED	
MH		JM		JP		BY JP	DATE 06/08/07	BY	DATE
Project Title		C HESAPEAKE CONTROLS, INC. Systems & Services Division				Branch Information		CONTRACT NUMBER	
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA						1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134	
								DRAWING NUMBER	
						D-36			

▲ NOT PROVIDED BY CHESAPEAKE CONTROLS

ROOF TOP UNIT #18

NOTE: CHECK MANUFACTURERS WIRING
DIAGRAMS BEFORE WIRING.
FACTORY DIAGRAMS WERE NOT AVAILABLE AT
SUBMITTAL STAGE AND THEREFORE WIRING
CHANGES MAYBE NECESSARY.



RTU SEQUENCE OF OPERATION

AT OCCUPANCY TIME, THE DDC CONTROLLER SHALL ENERGIZE THE UNIT.

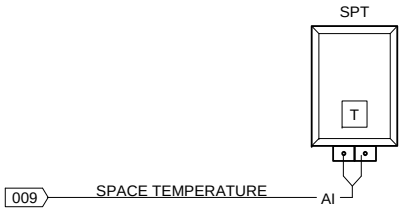
ON A RISE IN SPACE TEMPERATURE TO THE HEATING SETPOINT OF THE DDC CONTROLLER, THE DDC CONTROLLER SHALL MODULATE THE DUCT MOUNTED HOT WATER HEAT VALVE CLOSED TO THE COIL. ON A FURTHER RISE IN SPACE TEMPERATURE, THE DDC CONTROLLER SHALL ENERGIZE THE AIR-COOLED CONDENSING UNIT SECTION AND CYCLE THE COMPRESSORS TO MAINTAIN SPACE TEMPERATURE. ON A FALL IN SPACE TEMPERATURE, THE REVERSE SEQUENCE SHALL OCCUR.

UNIT FACTORY PROVIDED ECONOMIZER PACKAGE WILL CONTROL THE OPERATION OF UNIT DAMPERS.

*RE-USE EXISTING CONTROLLER

XL-10 CV-AHU CONTROLLER W7750C		
ADDRESS :		
B-O-M Tag :		
	EGND	1
	LED	2
	BYPASS	3
	SENSOR	4
	AGND	5
	SETPOINT	6
SA TEMP	AI 1 OHM	7
		8
SPACE TEMP	AI 2 OHM	9
	AI 3 V/mA	10
		11
	AI 4 V/mA	12
	22 VDC OUT	13
	E-BUS (FTT)	14
	E-BUS (FTT)	15
	AO 3	16
	AO 2	17
HW VALVE	AO 1	18
	TRIAC 5	19
	TRIAC 4	20
	TRIAC 3	21
SA FAN ENABLE	TRIAC 2	22
COOL ENABLE	TRIAC 1	23
	COM	24
	24 VAC IN	25
COOL STATUS	DI 1	26
		27
FAN STATUS	DI 2	28
	DI 3	29
		30
	DI 4	31

24VAC – POWER FROM UNIT
TRANSFORMER



RTU-18 Bill of Materials

DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
T1	DUCT TEMP SENSOR	HONEYWELL	C7041C2003	1
SPT	SPACE TEMP SENSOR	HONEYWELL	C7772A1004	1
V1	SEE VALVE SCHEDULE			

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DEMAND

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Drawing Title

ROOF TOP UNIT 18
WIRING DIAGRAM

Project Title

MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA

REFERENCE DRAWING
NO.
REVISION-LOCATION
ECN
DATE
BY

SALES ENGINEER
PROJECT MANAGER
APPLICATION ENGINEER
BY
DATE
06/08/07

CHESAPEAKE
CONTROLS, INC.
Systems & Services Division

Branch Information
1220 Executive Blvd
Suite 108
Chesapeake, VA
23320
(ph) 757-547-9738
(fax) 757-547-2781

CONTRACT NUMBER
0830-0134

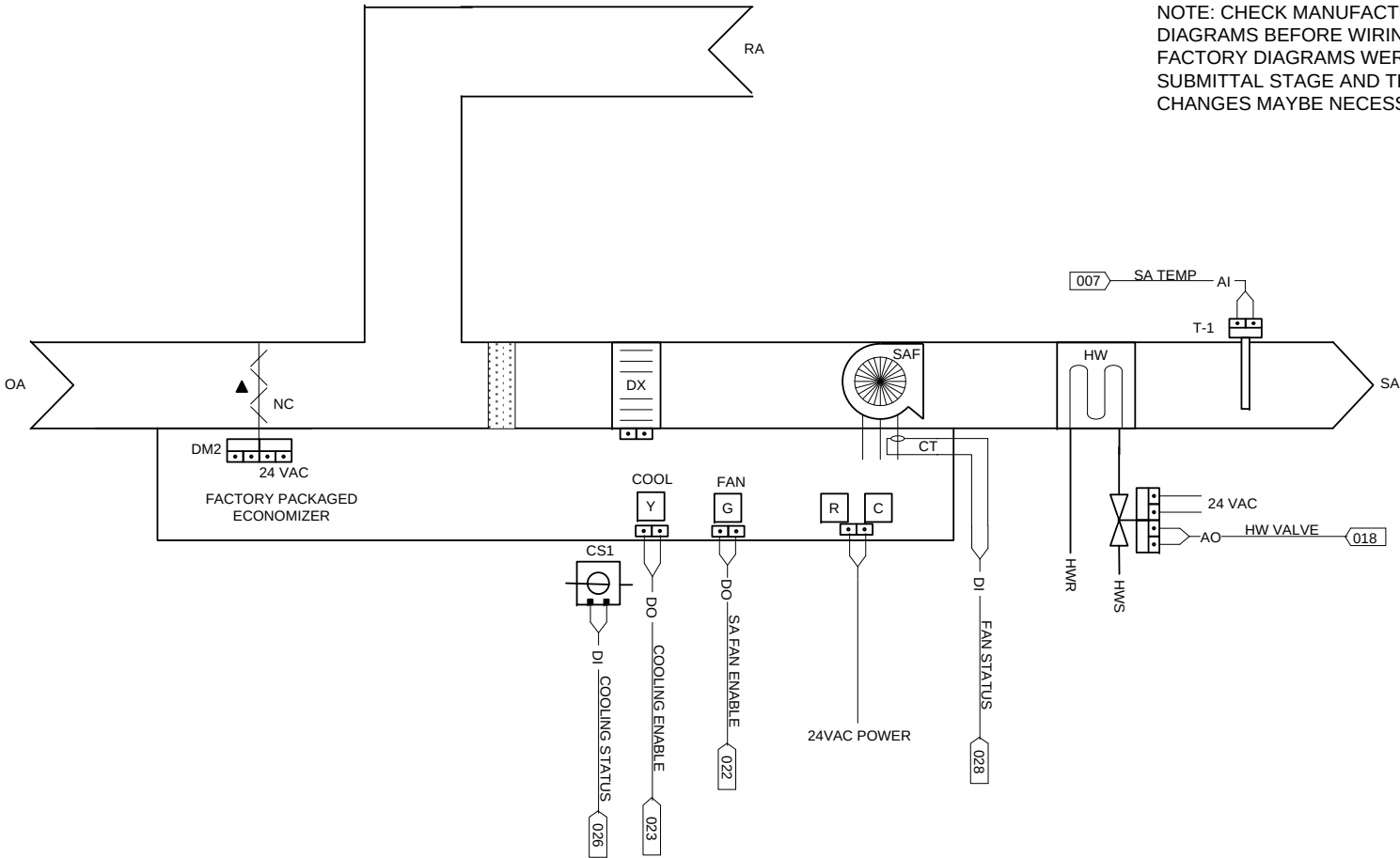
DRAWING NUMBER

D-37

▲ NOT PROVIDED BY CHESAPEAKE CONTROLS

ROOF TOP UNIT #19

NOTE: CHECK MANUFACTURERS WIRING
DIAGRAMS BEFORE WIRING.
FACTORY DIAGRAMS WERE NOT AVAILABLE AT
SUBMITTAL STAGE AND THEREFORE WIRING
CHANGES MAYBE NECESSARY.



RTU SEQUENCE OF OPERATION

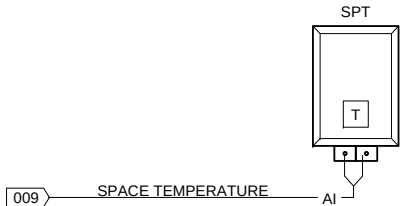
AT OCCUPANCY TIME, THE DDC CONTROLLER SHALL ENERGIZE THE UNIT.

ON A RISE IN SPACE TEMPERATURE TO THE HEATING SETPOINT OF THE DDC CONTROLLER, THE DDC CONTROLLER SHALL MODULATE THE DUCT MOUNTED HOT WATER HEAT VALVE CLOSED TO THE COIL. ON A FURTHER RISE IN SPACE TEMPERATURE, THE DDC CONTROLLER SHALL ENERGIZE THE AIR-COOLED CONDENSING UNIT SECTION AND CYCLE THE COMPRESSORS TO MAINTAIN SPACE TEMPERATURE. ON A FALL IN SPACE TEMPERATURE, THE REVERSE SEQUENCE SHALL OCCUR.

UNIT FACTORY PROVIDED ECONOMIZER PACKAGE WILL CONTROL THE OPERATION OF UNIT DAMPERS.

*RE-USE EXISTING CONTROLLER

XL-10 CV-AHU CONTROLLER W7750C		
ADDRESS :		
B-O-M Tag :		
	EGND	1
	LED	2
	BYPASS	3
	SENSOR	4
	AGND	5
	SETPOINT	6
SA TEMP	AI 1 OHM	7
		8
SPACE TEMP	AI 2 OHM	9
	AI 3 V/mA	10
		11
	AI 4 V/mA	12
	22 VDC OUT	13
	E-BUS (FTT)	14
	E-BUS (FTT)	15
	AO 3	16
	AO 2	17
HW VALVE	AO 1	18
	TRIAC 5	19
	TRIAC 4	20
	TRIAC 3	21
SA FAN ENABLE	TRIAC 2	22
COOL ENABLE	TRIAC 1	23
	COM	24
	24 VAC IN	25
COOL STATUS	DI 1	26
		27
FAN STATUS	DI 2	28
	DI 3	29
		30
	DI 4	31



RTU-19 Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
T1	DUCT TEM P SENSOR	HONEYWELL	C7041C2003	1
SPT	SPACE TEM P SENSOR	HONEYWELL	C7772A1004	1
V1	SEE VALVE SCHEDULE			

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Drawing Title									
ROOF TOP UNIT 19 WIRING DIAGRAM									
Project Title		Branch Information		CONTRACT NUMBER					
MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		1220 Executive Blvd Suite 108 Chesapeake, VA 23320 (ph) 757-547-9738 (fax) 757-547-2781		0830-0134					
		Systems & Services Division		DRAWING NUMBER		D-38			

CABINET UNIT HEATER

TYPICAL OF 20

CABINET UNIT HEATERS SEQUENCE OF OPERATION

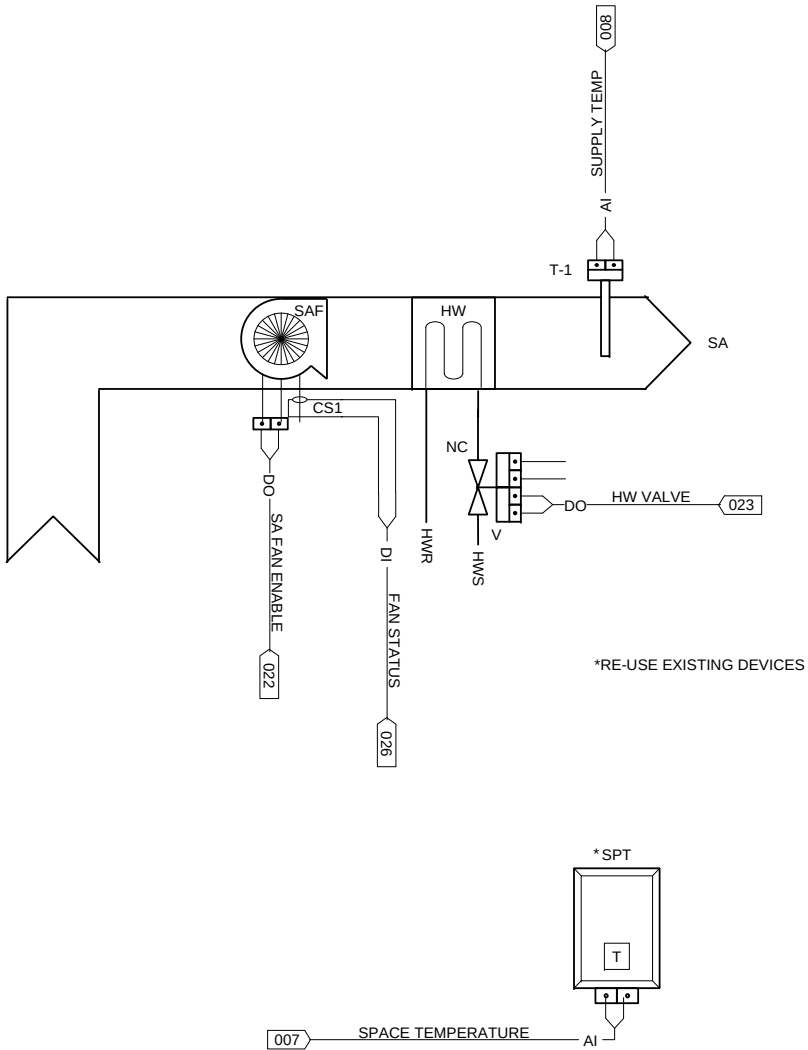
OCCUPIED MODE:

AT OCCUPANCY TIME THE UNIT HEATERS WILL BE ENABLED TO MAINTAIN OCCUPIED SPACE TEMPERATURE SETPOINT(71 DEGREES ADJUSTABLE). ON A FALL IN SPACE TEMPERATURE BELOW SETPOINT THE UNIT VALVE WILL BE OPENED AND THE FAN WILL BE ENERGIZED.

ONCE SPACE TEMPERATURE RISES ABOVE SETPOINT THE REVERSE WILL OCCUR.

UN-OCCUPIED MODE:

UNIT HEATER WILL BE CYCLED TO MAINTAIN UNOCCUPIED SETPOINT (60 DEGREES ADJUSTABLE).



*RE-USE EXISTING CONTROLLER

XL-10 CV-AHU CONTROLLER		
W7750C		
ADDRESS :		
B-O-M Tag :		
	EGND	1
	LED	+ 2
	BYPASS	+ 3
	SENSOR	+ 4
	AGND	- 5
	SETPOINT	+ 6
SPACE TEMP	AI 1 OHM	+ 7
		- 8
SUPPLY TEMP	AI 2 OHM	+ 9
	AI 3 V/mA	+ 10
		- 11
	AI 4 V/mA	+ 12
	22 VDC OUT	+ 13
	E-BUS (FTT)	14
	E-BUS (FTT)	15
	AO 3	16
	AO 2	17
	AO 1	18
	TRIAC 5	19
	TRIAC 4	20
	TRIAC 3	21
FAN ENABLE	TRIAC 2	22
HW VALVE	TRIAC 1	23
	COM	24
	24 VAC IN	25
FAN STATUS	DI 1	+ 26
		- 27
	DI 2	+ 28
	DI 3	+ 29
		- 30
	DI 4	+ 31

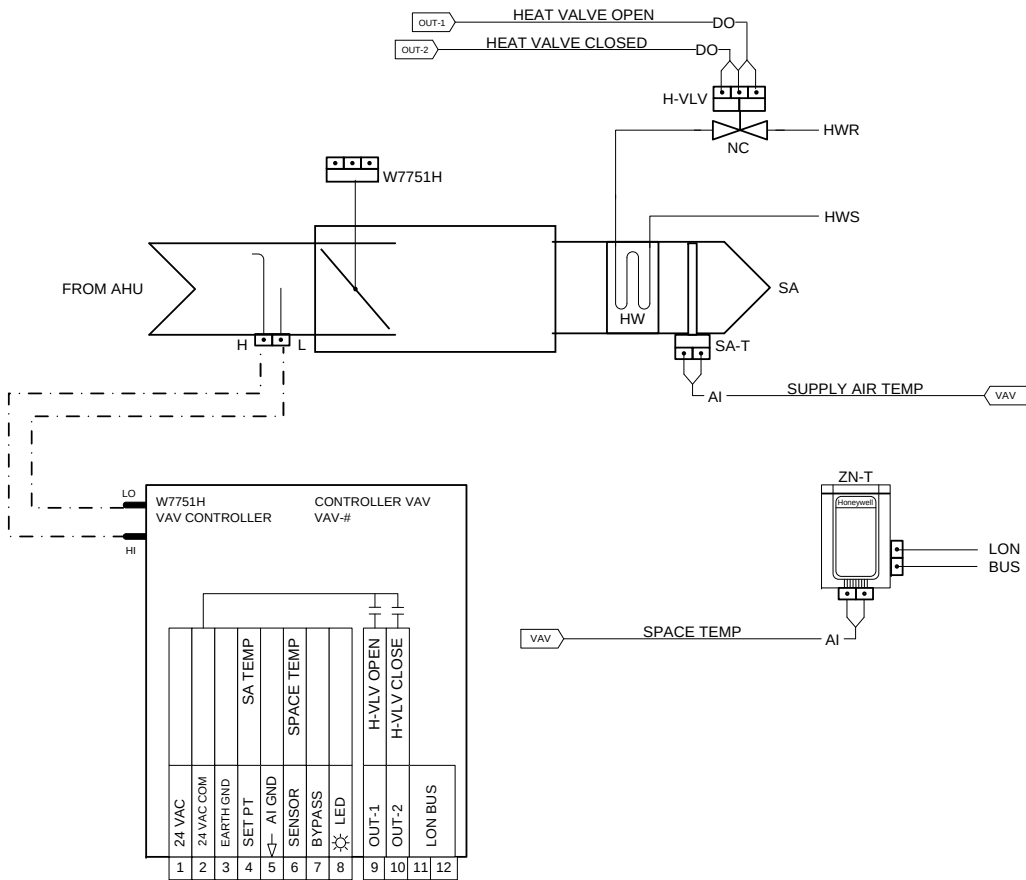
*SPT

Cabinet Unit Heaters Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
T1	DUCT TEM P SENSOR	HONEYWELL	C7041B2005	20
CS1	CURRENT SENSOR	VERIS	H-800	20
*	TRANSFORMER	VERIS	X050CBA	20
V	SEE VALVE SCHEDULE			

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	CABINET UNIT HEATER								
	Project Title		Branch Information		PROJECT NUMBER				
	HVAC UPGRADES MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC. Systems & Services Division		1220 Executive Blvd, Suite 108 Chesapeake, VA 23320 ph: (757)-547-9738 fax: (757)-547-2781 www.chesapeakecontrols.com		0830-0134		
							D-39		

VARIABLE AIR VOLUME BOXES

TYPICAL OF 170



Sequence of Operation: - Variable Air Volume VAV Boxes with Re-Heat

Occupied Mode - On a rise in space temperature above temperature setpoint (adjustable), the VAV box damper will modulate open to primary airflow for cooling. On a fall in space temperature, the box will modulate to a minimum position. On a continued fall in space temperature and once primary airflow is at its minimum flow position, the hot water valve will modulate open to provide heating. On a continued fall in space temperature, the primary airflow will increase to its maximum heating setpoint. On a rise in space temperature, the reverse shall occur.

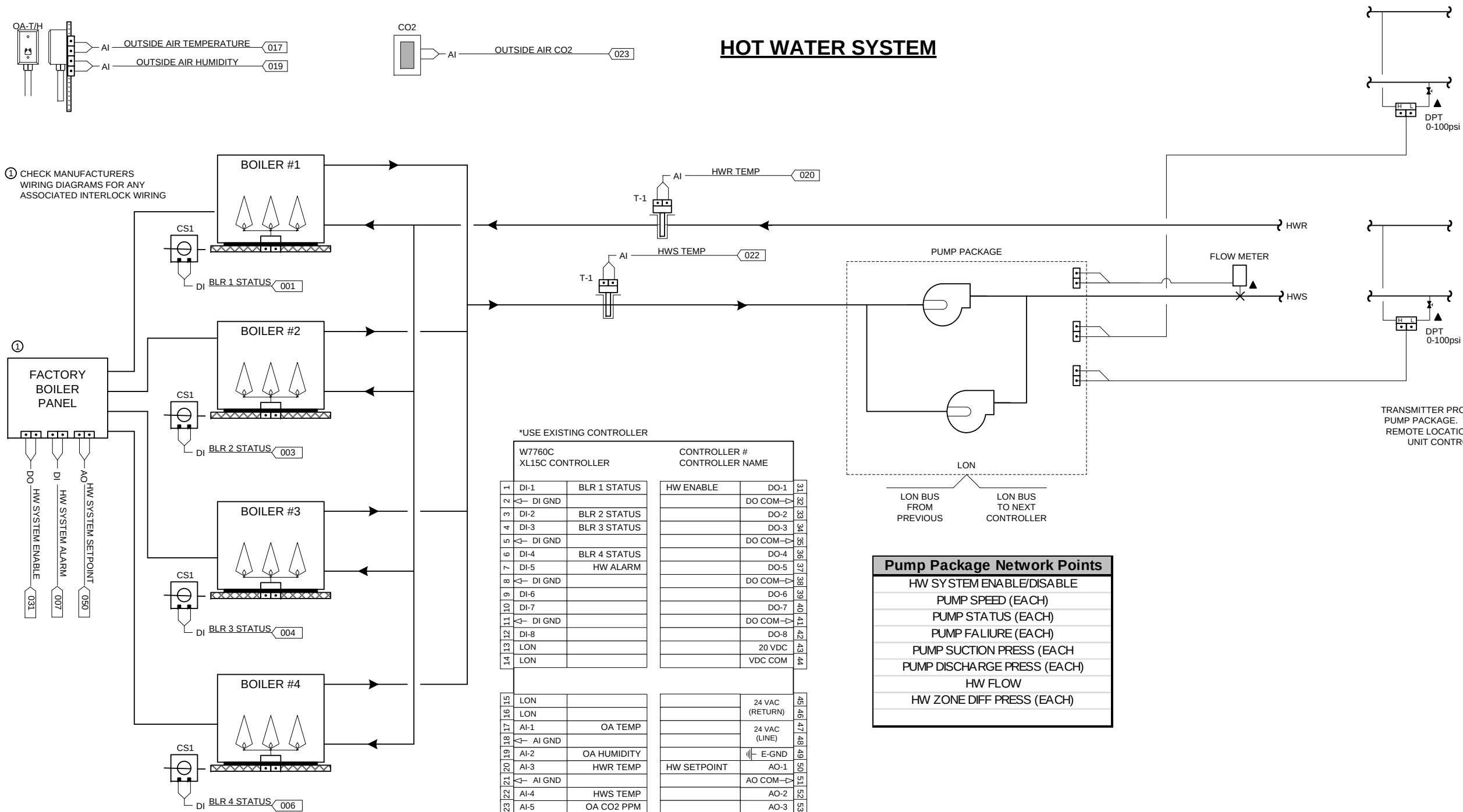
Morning Warm-up – VAV boxes will operate in reverse mode as long as associated rooftop air-conditioning unit is operating to provide warm primary air. Once warm-up cycle is terminated, the boxes will return to normal operation.

Unoccupied Mode - If space temperature falls below 65°F or rises above 80°F (adjustable), the associated rooftop air-conditioning unit will be brought online along with the VAV boxes being placed into operation. Once space temperature returns between nite lo and nite hi setpoints, the unit and VAV boxes will be placed back into unoccupied mode.

Bill of Materials

DEVICE ID	DESCRIPTION	MANUFACTURER	PART NO	QTY
VAV	CONTR, LON VAV INT ACT	HONEYWELL	W7751P2025	170
SA-T	SENS, DUCT, 20K NTC, .18"	HONEYWELL	C7041B2005	170
ZN-T	SENS, WALLPLATE, 20K NTC	DYNACON	TE205P17	170
HEAT VALVE	SEE VALVE SCHEDULE			

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	VARIABLE AIR VOLUME BOXES											
	Project Title		Branch Information				PROJECT NUMBER					
	HVAC UPGRADES MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC. Systems & Services Division				1220 Executive Blvd, Suite 108 Chesapeake, VA 23320 ph: (757)-547-9738 fax: (757)-547-2781 www.chesapeakecontrols.com				0830-0134	
							DRAWING NUMBER D-40					
			REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN	DATE	BY	
	Sales Engineer	Project Manager	Application Engineer		DRAWN		APPROVED					
	RE	JP	JP		BY	LE	DATE	01/05/09	BY	DATE		



*USE EXISTING CONTROLLER			CONTROLLER #	
W7760C XL15C CONTROLLER			CONTROLLER NAME	
1	DI-1	BLR 1 STATUS	HW ENABLE	DO-1
2	⌋ DI GND			DO COM-⌋
3	DI-2	BLR 2 STATUS		DO-2
4	DI-3	BLR 3 STATUS		DO-3
5	⌋ DI GND			DO COM-⌋
6	DI-4	BLR 4 STATUS		DO-4
7	DI-5	HW ALARM		DO-5
8	⌋ DI GND			DO COM-⌋
9	DI-6			DO-6
10	DI-7			DO-7
11	⌋ DI GND			DO COM-⌋
12	DI-8			DO-8
13	LON			20 VDC
14	LON			VDC COM
15	LON			24 VAC (RETURN)
16	LON			
17	AI-1	OA TEMP		24 VAC (LINE)
18	⌋ AI GND			
19	AI-2	OA HUMIDITY		⌋ E-GND
20	AI-3	HWR TEMP	HW SETPOINT	AO-1
21	⌋ AI GND			AO COM-⌋
22	AI-4	HWS TEMP		AO-2
23	AI-5	OA CO2 PPM		AO-3
24	⌋ AI GND			AO COM-⌋
25	AI-6			AO-4
26	AI-7			AO-5
27	⌋ AI GND			AO COM-⌋
28	AI-8			AO-6
29	⌋ GND			
30	⌋ GND			

Pump Package Network Points	
HW SYSTEM ENABLE/DISABLE	
PUMP SPEED (EACH)	
PUMP STATUS (EACH)	
PUMP FALIURE (EACH)	
PUMP SUCTION PRESS (EACH)	
PUMP DISCHARGE PRESS (EACH)	
HW FLOW	
HW ZONE DIFF PRESS (EACH)	

Hot Water System - Bill of Materials				
DEVICE ID	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
T1	DUCT TEMP SENSOR	HONEYWELL	C704ID2001	2
**	THERM OWELL	HONEYWELL	5000I774-001	2
CS1	RELAY	VERIS	H-800	1
OAT	OA TEMP/HUMIDITY SENSOR	VERIS	HEO3M STM	1
CO2	OA CO2 SENSOR	VERIS	CWE	1
**	ENCLOSURE FOR OA CO2	VERIS	AA36	1

HOT WATER SYSTEM SEQUENCE OF OPERATION

ON A FALL IN OUTSIDE AIR TEMPERATURE TO THE SETPOINT OF THE DDC CONTROLLER OR HEAT IS REQUIRED FOR DEHUMIDIFICATION, THE DDC CONTROLLER WILL ENERGIZE THE HOT WATER PUMP PACKAGE CONTROLLER TO ENABLE TO MODULAR BOILER CONTROLLER. REFER TO PUMP PACKAGE SEQUENCE OF OPERATION AND MODULAR BOILER SEQUENCE OF OPERATION.

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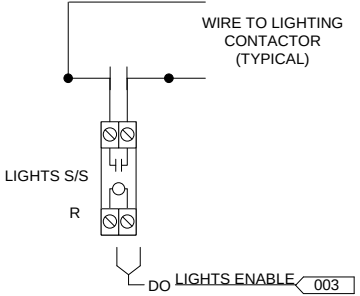
Drawing Title

HOT WATER SYSTEM

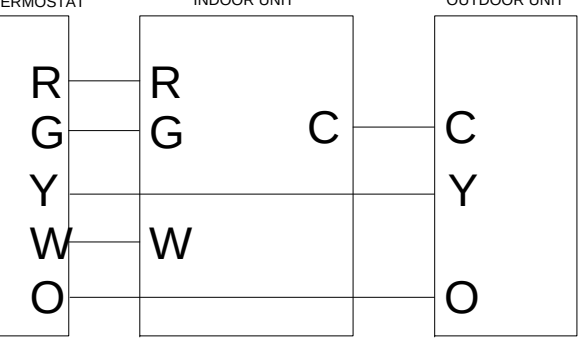
Project Title

HVAC UPGRADES
MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA

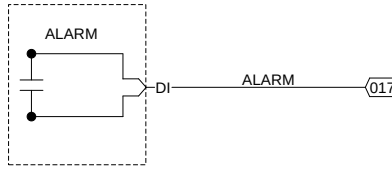
REFERENCE DRAWING		NO.	REVISION-LOCATION			ECN	DATE	BY			
Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED						
RE	JP	JP	BY	JLB	DATE	01/05/09	BY	DATE			
			Branch Information			PROJECT NUMBER					
			CHESAPEAKE CONTROLS, INC.			1220 Executive Blvd, Suite 108 Chesapeake, VA 23320 ph: (757)-547-9738 fax: (757)-547-2781 www.chesapeakecontrols.com					
			Systems & Services Division			0830-0134					
						DRAWING NUMBER					
						D-41					



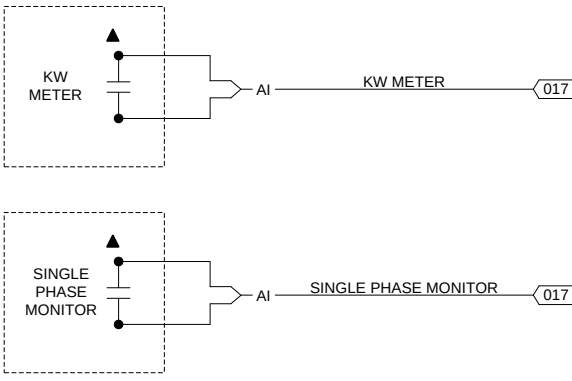
LIGHTING CONTROL



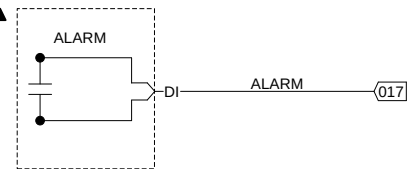
**SPLIT SYSTEM HEAT PUMP
DATA ROOM & ROOM E110**



**POWER SERVICE ENTRANCE
SURGE SUPPRESSION**

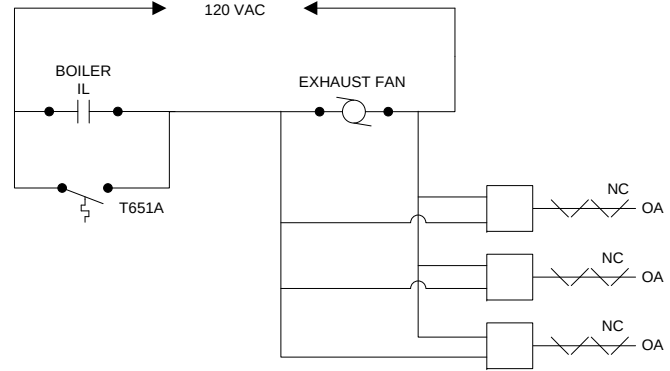


POWER MONITORING

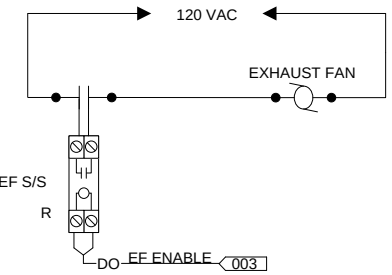


**PANELS
DP-1
DP-2
DP-3
DP-4**

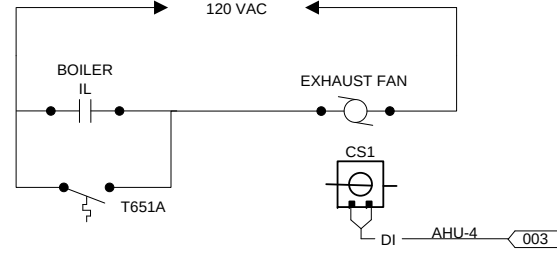
**POWER DISTRIBUTION
PANEL SURGE SUPPRESSION
(TYPICAL of 4)**



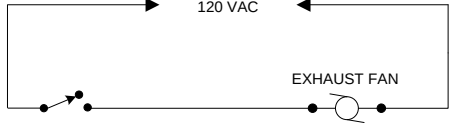
EXHAUST FAN #20



**TYPICAL FOR
EXHAUST FANS 2, 3, 5-9, 14,
15, 18 & 19**



EXHAUST FAN #4



EXHAUST FANS 10-13 & 16, 17

NOTE: POINTS TIED TO CLOSEST DDC CONTROLLER WITH SPARE POINTS

NEW EXHAUST FANS SEQUENCE OF OPERATION

REFER TO EXHAUST FAN SCHEDULE FOR TYPE OF CONTROL REQUIRED.

FOR TOILET EXHAUST FANS, CONTROL ON TIME-OF-DAY SCHEDULE FROM THE DDC SYSTEM.

SPLIT-SYSTEM HEAT PUMP & AIR-CONDITIONING UNIT CONTROL

UNIT SHALL BE CONTROLLED BY FACTORY CONTROLS.

PROVIDE A TEMPERATURE SENSOR TO THE DDC TO MONITOR ROOM TEMPERATURE.

SERVICE ENTRANCE SURGE SUPPRESSION DEVICES

THE DDC CONTROLLER SHALL MONITOR THE SERVICE ENTRANCE SURGE SUPPRESSION DEVICES. IF THE DEVICE GOES INTO ALARM, IT SHALL SEND AN ALARM TO THE HOST WORKSTATION

DISTRIBUTION PANELS SURGE SUPPRESSION DEVICES

THE DDC CONTROLLER SHALL MONITOR THE DISTRIBUTION PANELS SURGE SUPPRESSION DEVICES. IF THE DEVICE GOES INTO ALARM, IT SHALL SEND AN ALARM TO THE HOST WORKSTATION.

MISCELLANEOUS

EXTERIOR OUTDOOR AIR CO₂ SENSOR. PROVIDE CO₂ SENSOR EXTERIOR TO THE BUILDING FOR MONITORING AND DIFFERENTIAL INDOOR/OUTDOOR AHU CONTROL.

LIGHTING CONTROLS: THE LIGHTING CONTACTORS SHALL 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. REFER TO ELECTRICAL DRAWINGS FOR QUANTITY AND LOCATIONS.

SEQUENCE

BEFORE TRANSFER SWITCH IS SWITCH EO TO GENERATOR POWER OPERATOR MUST PRESS COOLING SHUTDOWN SWITCH

WHEN TRANSFER SWITCH IS TRANSFER BACK TO NORMAL POWER OPERATOR MUST PULL SHUTDOWN SWITCH TO ALLOW UNIT COOLING TO FUNCTION

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Drawing Title

MISCELLANEOUS

Project Title

HVAC UPGRADES
MENCHVILLE HIGH SCHOOL
NEWPORT NEWS, VIRGINIA

		1		GENERATOR INTERLOCK				1/02/09 JBP	
REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE	
Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED	
RE		JP		JP		BY LE		DATE 01/05/09	
						BY		DATE	

Branch Information

PROJECT NUMBER

DRAWING NUMBER

CHESAPEAKE

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Systems & Services Division

1220 Executive Blvd, Suite 108
Chesapeake, VA 23320
ph: (757)-547-9738
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www.chesapeakecontrols.com

0830-0134

D-42

Tag				Valve Information					Actuator Information			Comments
Item	Service	Type	Qty.	Valve & /Actuator OS #	Valve Size	GPM	Valve Cv	Actual Delta P	Actuator OS Number	Type	Control Signal	
RTU-1	Pre-Heat	2-Way	1	VBN2DL3P0D	1 1/4"	34	25	1.8	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-2	Pre-Heat	2-Way	1	VBN2BJ3P0D	3/4"	15	7.3	4.2	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-2	Re-Heat	2-Way	1	VBN2DL3P0D	1 1/4"	43.5	25	3.0	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-3	Hot Water	2-Way	1	VBN2BH3P0D	3/4"	7	4.3	2.7	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-4	Hot Water	2-Way	1	VBN2CL3P0D	1"	21.5	15	2.1	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-5	Pre-Heat	2-Way	1	VBN2BJ3P0D	3/4"	15	7.3	4.2	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-5	Re-Heat	2-Way	1	VBN2BJ3P0D	3/4"	10.3	7.3	2.0	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-6	Pre-Heat	2-Way	1	VBN2DL3P0D	1 1/4"	42	25	2.8	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-6	Re-Heat	2-Way	1	VBN2DL3P0D	1 1/4"	44	25	3.1	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-7	Hot Water	2-Way	1	VBN2CL3P0D	1"	26.5	15	3.1	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-8	Pre-Heat	2-Way	1	VBN2BJ3P0D	3/4"	15	7.3	4.2	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-8	Re-Heat	2-Way	1	VBN2BH3P0D	3/4"	8.3	4.3	3.7	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-9	Pre-Heat	2-Way	1	VBN2BJ3P0D	3/4"	15	7.3	4.2	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-9	Re-Heat	2-Way	1	VBN2BH3P0D	3/4"	9	4.3	4.4	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-10	Pre-Heat	2-Way	1	VBN2CL3P0D	1"	21	15	2.0	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-11	Pre-Heat	2-Way	1	VBN2BJ3P0D	3/4"	14	7.4	3.6	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-12	Pre-Heat	2-Way	1	VBN2BJ3P0D	3/4"	13	7.5	3.0	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-12	Re-Heat	2-Way	1	VBN2CL3P0D	1"	24.5	15	2.7	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-13	Pre-Heat	2-Way	1	VBN2BJ3P0D	3/4"	12	6.9	3.0	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-13	Re-Heat	2-Way	1	VBN2CJ3P0D	1"	17.5	9	3.8	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-14	Pre-Heat	2-Way	1	VBN2BJ3P0D	3/4"	13	7.5	3.0	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-14	Re-Heat	2-Way	1	VBN2CL3P0D	1"	25	15	2.8	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-15	Pre-Heat	2-Way	1	VBN2BJ3P0D	3/4"	14	7.4	3.6	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-16	Pre-Heat	3-Way	1	VBN3DM3P0D	1 1/4"	47	25	3.5	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-17	Pre-Heat	3-Way	1	VBN3DM3P0D	1 1/4"	47	25	3.5	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-18	Hot Water	2-Way	1	VBN2BE3P0D	3/4"	1.5	1.2	1.6	MS7505A2008	ELEC	24VAC	24VAC MODULATING
RTU-19	Hot Water	2-Way	1	VBN2BE3P0D	3/4"	1.5	1.2	1.6	MS7505A2008	ELEC	24VAC	24VAC MODULATING
CUHs	Hot Water	2-Way	20	VU53N1017	3/4"	5	8	0.4	VU843A1004	ELEC	24VAC	24 VAC 2 POSITION
				RTU Valve Number Includes Actuators								

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	MISCELLANEOUS								
	REFERENCE DRAWING		NO.	REVISION-LOCATION		ECN	DATE	BY	
	Sales Engineer RE	Project Manager JP	Application Engineer JP	DRAWN BY LE DATE 01/05/09		APPROVED BY DATE			
Project Title		Branch Information		PROJECT NUMBER					
HVAC UPGRADES MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC. Systems & Services Division		1220 Executive Blvd, Suite 108 Chesapeake, VA 23320 ph: (757)-547-9738 fax: (757)-547-2781 www.chesapeakecontrols.com		0830-0134 DRAWING NUMBER D-43			

AHU-1 VALVE SCHEDULE

Tag			Valve Information						Actuator Information			Comments
Item	Service	Type	Qty.	Valve & /Actuator OS #	Valve Size	GPM	Valve Cv	Actual Delta P	Actuator OS Number	Type	Control Signal	
VAV 1.1	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.2	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.3	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.4	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.5	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.6	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.7	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.8	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.9	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.10	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.11	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.12	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.13	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.14	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.15	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.16	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.17	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.18	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.19	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.20	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.21	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.22	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.23	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.24	Hot Water	2-Way	1	V5862A2047	1/2"	2	1.2	2.8	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.25	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.26	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.27	Hot Water	2-Way	1	V5862A2047	1/2"	2.5	1.2	4.3	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.28	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 1.29	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT

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	AHU-1 VALVE SCHEDULE										
	Project Title		Branch Information		PROJECT NUMBER		1220 Executive Blvd, Suite 108 Chesapeake, VA 23320 ph: (757)-547-9738 fax: (757)-547-2781 www.chesapeakecontrols.com				
	HVAC UPGRADES MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC. Systems & Services Division		0830-0134		D-44				
REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE		BY	
Sales Engineer RE		Project Manager JP		Application Engineer JP		DRAWN BY JLB		DATE 01/05/09		APPROVED BY	

AHU-10 VALVE SCHEDULE

Tag			Valve Information						Actuator Information			Comments
Item	Service	Type	Qty.	Valve & /Actuator OS #	Valve Size	GPM	Valve Cv	Actual Delta P	Actuator OS Number	Type	Control Signal	
VAV 10.1	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.2	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.3	Hot Water	2-Way	1	V5862A2047	1/2"	2	1.2	2.8	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.4	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.5	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.6	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.7	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.8	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.9	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.10	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.11	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.12	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.13	Hot Water	2-Way	1	V5862A2047	1/2"	2	1.2	2.8	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.14	Hot Water	2-Way	1	V5862A2047	1/2"	2	1.2	2.8	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.15	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.16	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.17	Hot Water	2-Way	1	V5862A2047	1/2"	2	1.2	2.8	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.18	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.19	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.20	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.21	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.22	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.23	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.24	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.25	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.26	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 10.27	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT

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	AHU-10 VALVE SCHEDULE											
	Project Title		Hvac Upgrades Menchville High School Newport News, Virginia		Chesapeake Controls, Inc. Systems & Services Division		1220 Executive Blvd, Suite 108 Chesapeake, VA 23320 ph: (757)-547-9738 fax: (757)-547-2781 www.chesapeakecontrols.com		PROJECT NUMBER 0830-0134 DRAWING NUMBER D-45			
	REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE		BY	
	Sales Engineer RE		Project Manager JP		Application Engineer JP		DRAWN BY JLB DATE 01/05/09		APPROVED BY _____ DATE _____			

AHU-11 VALVE SCHEDULE

Tag			Valve Information						Actuator Information			
Item	Service	Type	Qty.	Valve & /Actuator OS #	Valve Size	GPM	Valve Cv	Actual Delta P	Actuator OS Number	Type	Control Signal	
VAV 11.1	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 11.2	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 11.3	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 11.4	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 11.5	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 11.6	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 11.7	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 11.8	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 11.9	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 11.10	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT

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	AHU-11 VALVE SCHEDULE								
	Project Title		1220 Executive Blvd, Suite 108 Chesapeake, VA 23320 ph: (757)-547-9738 fax: (757)-547-2781 www.chesapeakecontrols.com			PROJECT NUMBER			
	HVAC UPGRADES MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC. Systems & Services Division			DRAWING NUMBER			
						0830-0134			D-46

AHU-15 VALVE SCHEDULE

Tag			Valve Information						Actuator Information				
Item	Service	Type	Qty.	Valve & /Actuator OS #	Valve Size	GPM	Valve Cv	Actual Delta P	Actuator OS Number	Type	Control Signal	Comments	
VAV 15.1	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.2	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.3	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.4	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.5	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.6	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.7	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.8	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.9	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.10	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.11	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.12	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.13	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.14	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.15	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.16	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 15.17	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT

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	AHU-15 VALVE SCHEDULE									
	Project Title		1220 Executive Blvd, Suite 108 Chesapeake, VA 23320 ph: (757)-547-9738 fax: (757)-547-2781 www.chesapeakecontrols.com			PROJECT NUMBER		0830-0134		
	HVAC UPGRADES MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		CHESAPEAKE CONTROLS, INC. Systems & Services Division			DRAWING NUMBER		D-47		

AHU-16A VALVE SCHEDULE

Tag			Valve Information						Actuator Information				
Item	Service	Type	Qty.	Valve & /Actuator OS #	Valve Size	GPM	Valve Cv	Actual Delta P	Actuator OS Number	Type	Control Signal		
VAV 16.1	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.2	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.3	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.4	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.5	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.6	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.7	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.8	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.9	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.10	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.11	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.12	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.13	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.14	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.15	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.16	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.17	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.18	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.19	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 16.20	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT

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	AHU-16A VALVE SCHEDULE										
	Project Title		CHESAPEAKE CONTROLS, INC. Systems & Services Division		1220 Executive Blvd, Suite 108 Chesapeake, VA 23320 ph: (757)-547-9738 fax: (757)-547-2781 www.chesapeakecontrols.com		PROJECT NUMBER 0830-0134 DRAWING NUMBER D-48				
REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE		BY	
Sales Engineer RE		Project Manager JP		Application Engineer JP		DRAWN BY JLB DATE 01/05/09		APPROVED BY DATE			

AHU-16B VALVE SCHEDULE

Tag			Valve Information						Actuator Information			Comments
Item	Service	Type	Qty.	Valve & /Actuator OS #	Valve Size	GPM	Valve Cv	Actual Delta P	Actuator OS Number	Type	Control Signal	
VAV 16.21	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.22	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.23	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.24	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.25	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.26	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.27	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.28	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.29	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.30	Hot Water	2-Way	1	V5862A2021	1/2"	2	0.47	18.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.31	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.32	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.33	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.47	10.2	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.34	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.35	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.36	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.37	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.38	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.39	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.40	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.41	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.42	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 16.43	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT

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	AHU-16B VALVE SCHEDULE								
	Project Title		Branch Information		PROJECT NUMBER		0830-0134		
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REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE	
Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED	
RE		JP		JP		BY JLB DATE 01/05/09		BY DATE	

AHU-17A VALVE SCHEDULE

Tag			Valve Information						Actuator Information				
Item	Service	Type	Qty.	Valve & /Actuator OS #	Valve Size	GPM	Valve Cv	Actual Delta P	Actuator OS Number	Type	Control Signal		
VAV 17.1	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.2	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.3	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.4	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.5	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.6	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.7	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.8	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.9	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.10	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.11	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.12	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.13	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.14	Hot Water	2-Way	1	V5862A2039	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.15	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.16	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.17	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.18	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.19	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.20	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.21	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT
VAV 17.22	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC	MODULATE FLOAT

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	AHU-17A VALVE SCHEDULE										
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	Hvac Upgrades Menchville High School Newport News, Virginia		CHESAPEAKE CONTROLS, INC. Systems & Services Division		DRAWING NUMBER		D-50				
	REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE		BY
Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED			
RE		JP		JP		BY JLB DATE 01/05/09		BY		DATE	

AHU-17B VALVE SCHEDULE

Tag			Valve Information						Actuator Information			Comments
Item	Service	Type	Qty.	Valve & /Actuator OS #	Valve Size	GPM	Valve Cv	Actual Delta P	Actuator OS Number	Type	Control Signal	
VAV 17.23	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.24	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.25	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.26	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.27	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.28	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.29	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.30	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.31	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.32	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.33	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.34	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.35	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.36	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.37	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.38	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.39	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.40	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.41	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.42	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.43	Hot Water	2-Way	1	V5862A2039	1/2"	1.5	0.74	4.1	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT
VAV 17.44	Hot Water	2-Way	1	V5862A2021	1/2"	1	0.47	4.5	M6410A1029	ELEC	24VAC	24VAC MODULATE FLOAT

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	AHU-17B VALVE SCHEDULE								
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	HVAC UPGRADES MENCHVILLE HIGH SCHOOL NEWPORT NEWS, VIRGINIA		Systems & Services Division				DRAWING NUMBER D-51		
REFERENCE DRAWING		NO.		REVISION-LOCATION		ECN		DATE	
Sales Engineer		Project Manager		Application Engineer		DRAWN		APPROVED	
RE		JP		JP		BY JLB DATE 01/05/09		BY DATE	

DETAIL C1:

TEMPERATURE SENSOR INPUT

NOTE: IF SHIELDED CABLE IS USED SEE DETAIL A-SHIELD-GROUND FOR SHIELD TERMINATION

DETAIL C2:

T7770 TERMINAL BLOCK

TERM	FUNCTION
1	LON
2	LON
3	AI COMMON
4	SENSOR
5	SETPOINT
6	BYPASS
7	LED
8	NOT USED

T7770

NOTE: 1. IF SHIELDED CABLE IS USED SEE DETAIL A-SHIELD-GROUND FOR SHIELD TERMINATION.

DETAIL C5:

2-10VDC INPUT INTERNAL SOURCE

NOTE: IF SHIELDED CABLE IS USED SEE DETAIL A-SHIELD-GROUND FOR SHIELD TERMINATION

DETAIL C21:

2-10vdc ANALOG OUTPUT

NOTE: IF SHIELDED CABLE IS USED SEE DETAIL A-SHIELD-GROUND FOR SHIELD TERMINATION

DETAIL C23:

S-SERIES 2-10 VDC OUTPUT

W7750C ONLY

ACTUATOR

V

OR +

OR N/A

FEEDBACK

2-10 VDC

10-2 VDC

0-10 VDC

10-0 VDC

FLTG FWD

FLTG REV

DETAIL C55

24 VAC BINARY OUTPUT

NOTE: TRIAC JUMPER J2 SET FOR HIGH SIDE SWITCHING FOR W7750B MODELS

DETAIL C70

N.O. BINARY INPUT

LON W7750

LON COMMUNICATION

W7750

14 LON

15 LON

NOTE: IF SHIELDED CABLE IS USED DO NOT GROUND SHIELD ON EITHER END

LON(EOL)

LON COMMUNICATION (END OF LINE)

YELLOW

BROWN

ORANGE

14 LON

15 LON

NOTE: IF SHIELDED CABLE IS USED DO NOT GROUND SHIELD ON EITHER END

DETAIL A1:

T7770 TERMINAL BLOCK

TERM	FUNCTION
1	LON
2	LON
3	AI COMMON
4	SENSOR
5	SETPOINT
6	BYPASS
7	LED
8	NOT USED

T7770

NOTE: 1. IF SHIELDED CABLE IS USED SEE DETAIL A-SHIELD-GROUND FOR SHIELD TERMINATION.

DETAIL A3:

C7750A DISCHARGE AIR TEMPERATURE SENSOR INPUT

NOTE: IF SHIELDED CABLE IS USED SEE DETAIL A-SHIELD-GROUND FOR SHIELD TERMINATION. SENSOR MUST BE CONFIGURED AS DISCHARGE AIR IN CONTROLLER.

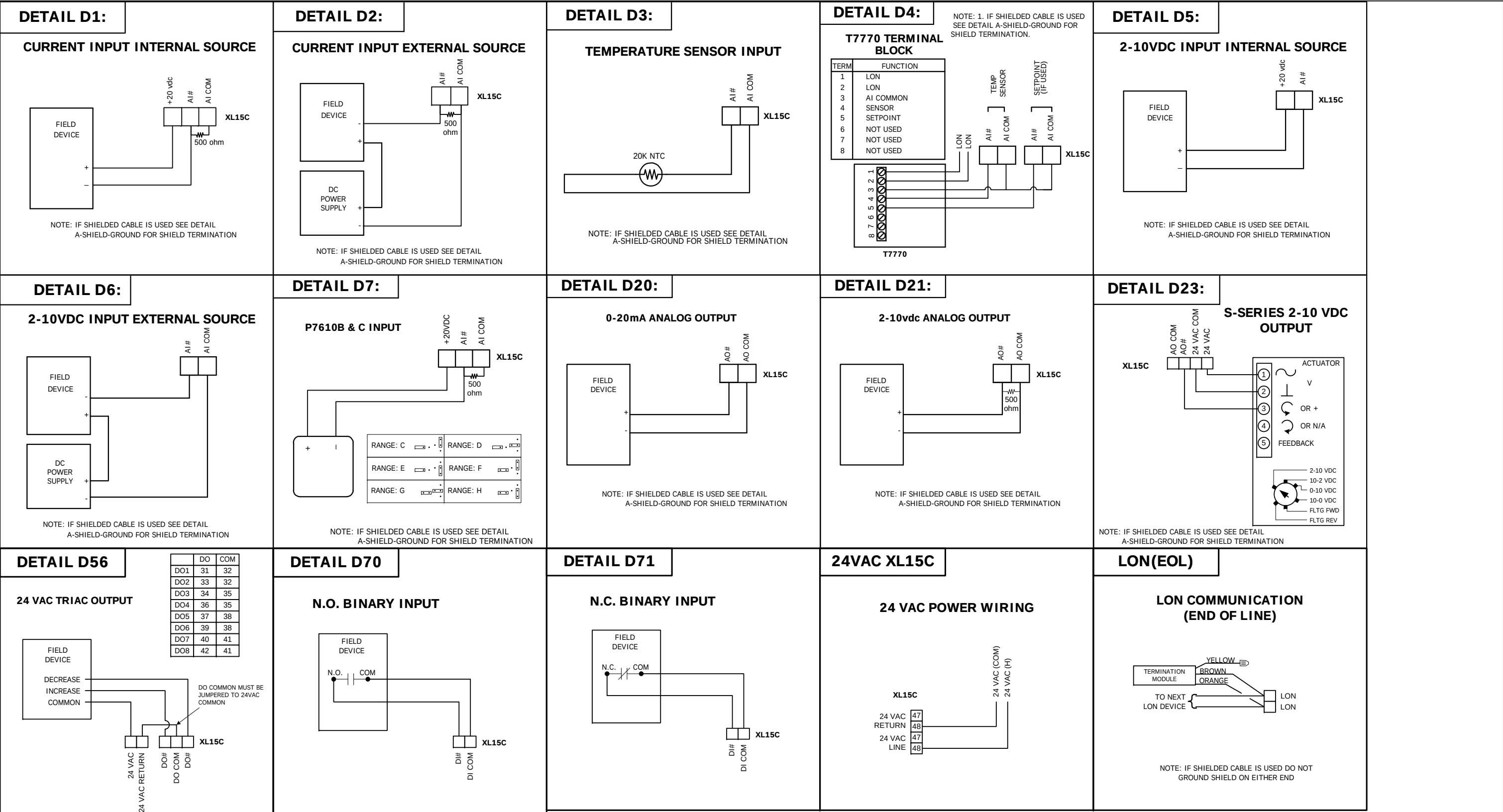
DETAIL A51

M6410 SERIES ACTUATOR FLOATING OUTPUT

LEGEND

AI
AO
C-x
C-VLV
CHS
CHR
CHW
COND
DA-SP
DA-T
DI
DO
DPR
DD-SP
DX
EF
EF-S
ENCL
FAN-S
FILTER-S
FZ-ALM
HW
HWR
HWS
H-VLV
LPS
MA-T
NC
NO
OA
OA-DMPR
OA-VP
PS
R
RA
RA-DMPR
RA-H
RA-T
REL-DMPR
SA
SF
SF-S
VAV
XFMR
ZN-T

ANALOG INPUT
ANALOG OUTPUT
DDC CONTROLLER
COOLING VALVE
CHILLED WATER SUPPLY
CHILLED WATER RETURN
CHILLED WATER
STEAM CONDENSATE
DISCHARGE AIR STATIC PRESSURE
DISCHARGE AIR TEMPERATURE
DIGITAL INPUT
DIGITAL OUTPUT
DAMPER ACTUATOR
DOWN DUCT STATIC PRESSURE
DIRECT EXPANSION COOLING
EXHAUST FAN
EXHAUST FAN STATUS
PANEL ENCLOSURE
FAN STATUS
FILTER STATUS - DIFF. PRESSURE
FREEZE THERMOSTAT
HOT WATER
HOT WATER RETURN
HOT WATER SUPPLY
HEATING VALVE
LOW PRESSURE STEAM
MIXED AIR TEMPERATURE
NORMALLY CLOSED
NORMALLY OPEN
OUTSIDE AIR
OUTSIDE AIR DAMPER
OUTSIDE AIR VELOCITY PRESSURE
POWER SUPPLY
RELAY
RETURN AIR
RETURN AIR DAMPER
RETURN AIR HUMIDITY
RETURN AIR TEMPERATURE
RELIEF AIR DAMPER
SUPPLY AIR
SUPPLY FAN
SUPPLY FAN STATUS
VARIABLE AIR VOLUME
TRANSFORMER
ZONE TEMPERATURE



SECTION 232533 - WATER TREATMENT AND TEMPORARY SUB-MICRON FILTRATION
HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following for hydronic systems:
 - 1. Chemicals
 - 2. Temporary hydronic sub-micron filtration

1.3 DEFINITIONS

- A. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water.
- B. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, installation diagrams, and furnished specialties and accessories for the following products:
 - 1. Chemical material safety data sheets.
 - 2. Laser Particle Distribution (LPD) Water Analysis.
 - 3. Spill containment.

1.5 CLOSEOUT SUBMITTALS

- A. Laser Particle Distribution (LPD) Water Analyses.
- B. Chemical service reports for each hydronic system.
- C. Legionella test reports for open loop systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide and install all chemical, components and additional materials required to maintain proper water treatment in hydronic systems. The contents of this specification are written with the intention to control scale, corrosion and microbiological fouling and provide high quality water for high efficiency HVAC systems.
- B. Provide and install temporary sub-micron filtration equipment. Sub-micron filtration should be provided for the duration of construction or a minimum of 90 days to ensure hydronic system is clean and free of TSS. Sub-micron filtration shall reduce TSS to the sub-micron level to reduce system fouling, clogged strainers, system down time, and prevent reduction in design efficiency.

2.2 CLOSED LOOP SYSTEMS

- A. Provide and install on each closed water recirculating system, a 5-gallon bypass pot feeder. Feeder shall be of steel construction and shall have a working pressure of 300 psi. Provide inlet, outlet and drain valves. Feeder shall sit on stands and have a drain at the bottom.
- B. Provide Jacklyn Industries WM 8588 Neutral pH pre-operation cleaner prior to system start-up to remove oil and mill-scale from system.
- C. Provide Jacklyn Industries WM 8676 Nitrite corrosion inhibitor.

2.3 TEMPORARY HYDRONIC SUB-MICRON FILTRATION

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Waltz Engineered Sales Sub-Micron Filtration
- B. The Hydronic Sub-Micron Filtration system shall be designed to filter water in open and closed HVAC hydronic loops. The filter system shall be installed in a side stream method to the hydronic loops to allow the removal of suspended solids down to 0.45 micron nominal. The filters shall be fully automated to perform continuous filtration and backwash cycles based on pressure differential and/or time.
- C. Nominal continuous 0.45 sub-micron multi-media for removal of suspended solids. Must use Cross-Radial Flow Technology (percolation filtration is not acceptable), maximizing contact between process water and the filter's media and not compressing the media with a direct downward force.
- D. 16" filters are rated for 35 GPM filtrate capacity. Footprint dimension: 34" wide x 34" length x 65" height. Filter shall be mounted on a portable base.

- E. Company supplying rental filtration shall have a minimum of 10 years' experience in sub-micron filtration rental.
- F. Contractor shall hire a third-party sub-micron filtration specialist. Start filtration once the system is filled following the pre-clean process, and filter for a minimum of 90 days per system. Approved contractors listed below:
 - 1. Waltz Engineered Sales Sub-Micron Filtration
- G. Contractor must provide proof of sanitization proving filter has been properly sanitized to reduce system cross contamination risks.
- H. Contact: Waltz Engineered Sales, Inc. (866) 829-0005.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Particle Distribution (LPD) Water Analysis: Filter supplier shall conduct two (2) LPD analyses for each filter to include an initial water sample from all hydronic water circulating loops at the filter inlet. At the end of the 90-day period, one (1) additional water sample will be taken from the filter inlet for performance evaluation. LPD analyses shall be conducted by an independent water analysis laboratory. Before filter is disconnected, contractor shall forward a copy of all documented results to the engineer for final review.
- B. Perform an analysis of the domestic supply water on the project site to establish incoming water quality baseline.

3.2 WATER TREATMENT EQUIPMENT INSTALLATION

- A. Install bypass piping around the main system pumps.
- B. Install all equipment level and plumb.
- C. Line side power wiring shall be provided by Division 26 - Electrical. Provide certified wiring schematics to Division 26 - Electrical for associated equipment
- D. Install five gallon shot feeder in main pump bypass piping on closed loop systems (One for each closed loop system).
- E. Install inlet and outlet shut-off valves for all hydronic water treatment equipment.
- F. Allow enough space to service and use water treatment equipment.

3.3 TEMPORARY HYDRONIC SUB-MICRON FILTRATION INSTALLATION

- A. Piping taps for the temporary filter shall be 1 1/2", with 1 1/2" ball valves for filter isolation. Taps shall be located at either 3:00 or 9:00 o'clock on either the supply or return header loop with a minimum distance of 6'-0" apart. Unit shall be located within 20'-0" of piping taps. All piping to and from filter shall be provided by contractor. Contractor shall coordinate filter taps and location.
- B. Backwash Supply: Filter systems shall require city water for backwash at a minimum of 20 GPM at 30-100 PSIG. Piping for backwash shall be minimum 3/4" diameter.
- C. Backwash Drain: Filter systems shall require minimum 1" diameter to nearest drain.
- D. Electrical: Filter system shall operate at 120V/1ph/60HZ. Electrical cord shall be supplied for receptacle connection.
- E. Temporary Filter shall have all necessary components to provide a working sub-micron filtration system on each system for a minimum of 90 days.

3.4 WATER TREATMENT SERVICE

- A. One sole contractor shall be responsible for administering the cleaning, flushing, filtering, and complete water treatment process.
- B. Following initial fill and leak test by mechanical contractor, water treatment contractor shall install pre-treatment cleaner for the removal of oil, dirt, and mill-scale from the construction process. Allow cleaner to circulate for 24-48 hours. Mechanical contractor shall operate all system isolation valves and coordinate with the controls contractor to ensure all legs of the hydronic system have been opened. All components shall be on-line with exception to the equipment utilizing flushing bypasses to prevent unit clogging during the startup and cleaning process.
- C. After system has been circulated for the recommended amount of time, begin a running flush to remove the cleaner chemical from the system. Flush system until the pH of system is within 0.5 of the domestic water pH and 10% of the domestic conductivity.
- D. Install corrosion inhibitor for all systems and maintain system parameters within the following limits:

1. Closed Loop Systems:

Parameter	Limit
Total Hardness (ppm)	30-500
Alkalinity (ppm)	30-500
Chlorides (ppm)	Less than 200
Conductivity (µS/cm)	Less than 3,000
pH	8-11
TDS (ppm)	Less than 2,000
Sodium Nitrite (ppm)	800-1200

- E. Install and start sub-micron filters on all hydronic systems and perform initial LPD Analyses.
- F. The water treatment contractor shall make regular visits to the site during the first year's operation (once a month). A report containing findings and recommendations shall be submitted to the Owner following each visit.
- G. Provide monthly legionella testing for all open tower systems beginning at start-up and for the duration of the contract. Tests shall utilize the quantitative direct fluorescent monoclonal antibody (DFA) test for 14 serogroups of Legionella pneumophila.
- H. At project completion, provide water quality reports for each system. Provide reports for initial and final LPD analyses and all monthly legionella reports for open loop systems.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

END OF SECTION 232533

SECTION 260100 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. This Section of the Specifications describes the material and installation procedures to be followed for furnishing and installing the electrical equipment and material as outlined and described on the contract drawings and as stated in this Division of the Specifications.
- B. Where the word "Contractor" appears in this Division of the Specifications, it applies to the Contractor performing the electrical portion of the work, unless specifically indicated otherwise.
- C. The Contractor shall install the systems as specified herein and indicated on the contract drawings and shall furnish all labor, material, tools, scaffolds, erection equipment, services and other items of expense as necessary as a part of this Contract. This Contract further includes placing the systems into operation and properly testing, adjusting, balancing and training the owner's personnel on the use of all items of equipment as specified and as approved by the Engineer.

1.3 SUPERVISION

- A. The Electrical Contractor shall have a competent and English speaking designated Supervisor who is a Certified Master Electrician on the job site at all times that any electrical work is being performed. This shall include 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 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 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
CBMA	Certified Ballast Manufacturers Association
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IECC	International Energy Conservation Code
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
LEED	Leadership in Energy and Environmental Design
NEC 2017	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Prevention Association
NFPA 70E	Standard for Electrical Safety in the workplace
OSHA	The Occupational Safety and Health Act
UL	Underwriters Laboratories, Inc.
VUSBC	Virginia Uniform Statewide Building Code, 2018 Edition

- B. All equipment, material, apparatus, and work shall conform to the requirements of the NEC. If the Contractor observes that the drawings and specifications are at variance therewith, the

contractor shall notify the Engineer in writing. If the Contractor performs such work contrary to the above referenced rules and regulations and without written acknowledgment or notice thereto, they shall correct this work and bear all cost arising therefrom.

1.7 NOTICES AND FEES

- A. Give all required notices, obtain all necessary permits, and pay all required fees, including any fees associated with temporary electrical power services during construction. Utility company fees, which are for the permanent installation of electrical power services, shall be paid for by the Owner.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. Refer to Specification 013300 "Submittals", for shop drawing submittal procedures. Submit shop drawings for materials required for this project as indicated herein. Obtain approval from the Engineer before manufacture is started on any of same. The shop drawings shall show complete details of the various items, wiring diagrams, etc., and shall be submitted in a sufficient number of copies to allow the Engineer to retain one copy. Approved copies of all shop drawings shall be kept on the job site accessible to the Engineer at all times. All new power distribution equipment (switchboards, panelboards, disconnect switches, transformers, contactors, and other power related components) shall all be by the same manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

- A. The following list states specific names of acceptable manufacturers of particular equipment and indicates the types of material on which submittals shall be made:

Submittal
Information
Required:

Power Distribution Equipment (Panelboards)
General Electric / ABB Company
Square D Company
Eaton/Cutler-Hammer
Siemens

Shop Drawings

Disconnect Switches Product Data
General Electric / ABB Company
Square D Company
Eaton/Cutler-Hammer
Siemens

Magnetic Contactors Product Data
General Electric / ABB Company
Square D Company
Eaton/Cutler-Hammer
Siemens

Surge Protective Devices..... Product Data
Liebert
Square D
Eaton

Wiring Devices and Cover Plates Product Data
Hubbell
Leviton
Arrow-Hart
Pass and Seymour

Dry-type Transformers Product Data
General Electric / ABB Company
Square D Company
Eaton/Cutler-Hammer
Siemens

- B. The following list states other materials for which product data submittals shall be made:

Circuit Breakers (each type)
Conductors (each type)
Conduit (each type)
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. Refer to Specification Section 012500 for substitution requirements.

- E. 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.

- F. 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.
- G. 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

- 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.
- b. Verify phase rotation of existing system with the power company and existing equipment to be reconnected prior to removal.

4. Continuation of Service:

- a. Maintain continuity of existing circuits to remain. Existing circuits shall remain energized unless otherwise indicated. Circuits which are to remain but were disturbed during demolition shall have circuit wiring and power restored back to original condition as approved by the Engineer. Only materials specified for this project may be used to affect repairs.

3.4 EXCAVATION

- A. All excavations shall be made to the proper depth to assure a firm foundation for the work.

3.5 RECORD DRAWINGS

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

3.6 OPERATION AND MAINTENANCE MANUALS

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

The following list states materials for which Operation and Maintenance Data submittals shall be made:

Power Distribution Equipment (Panelboards, Dry Type Transformers, and Disconnect Switches)

3.7 EQUIPMENT INVENTORY

- A. Provide a complete equipment inventory for all Electrical Equipment listed below. Refer to Appendix A in this section for the required template. A separate form shall be provided for each new piece of equipment provided.
- B. Prior to substantial completion, submit the equipment inventory forms for review. Once approved, include the forms in the operation and maintenance manual.

The following list states materials for which equipment inventory shall be made:

Power Distribution Equipment (Panelboards, Dry Type Transformers & 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, including all components thereof except as otherwise noted herein or in other specifications. The warranty start date is the date of project "Substantial Completion" as determined by the Engineer. All warranties shall be submitted as part of the shop drawing submittals.
- B. Electronic Fluorescent and HID Ballasts shall be free from defect in material and workmanship for a period of five (5) years from the date of project "Substantial Completion" as determined by the Engineer.
- C. Electronic LED drivers shall be free from defect in material and workmanship for a period of five (5) years from the date of project "Substantial Completion" as determined by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Electrical material furnished under these Specifications shall be new and listed by UL and shall

bear the UL label where labeling service is available for the type of material provided for this project.

2.2 RACEWAYS

- A. Raceways shall be of the size indicated or as required by the NEC; whichever is the larger; except where larger conduits are specified on the Contract Drawings. Raceways shall be 1/2" minimum.
- B. Raceways shall be provided for all electrical systems indicated on the drawings unless specifically indicated otherwise. Raceways shall be hot-dip galvanized rigid steel conduit (GRS), electrical metallic tubing (EMT), flexible steel conduit, or intermediate metallic conduit (IMC). Flexible steel conduit run 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 unless specifically noted otherwise.

2.4 OUTLETS

- A. Outlet and junction boxes shall be of one-piece galvanized construction of a type and size applicable for use in the location indicated on the contract drawings and as required by the NEC.
- B. Locations of outlets for lighting, devices, power, and equipment are indicated on the contract drawings. Owing to the small scale of the drawings, it is not possible to indicate the exact location. Examine the mechanical drawings, and finish conditions and arrange work as required to meet such conditions to the approval of the Engineer.
- C. Verify the exact swing of doors and locations of furniture and built-in cabinetry prior to installing outlets for switches and receptacles and make the necessary adjustments in location and mounting height of same to avoid conflicts at no additional cost. Coordinate outlets with change orders, addenda, and job site differences.

2.5 FUSES

- A. All fuses shall be provided by the Electrical Contractor.
- B. Fuses shall be as follows:

1. General: All fuses must carry the UL inspected label. All fuses shall be plainly marked with ampere rating, voltage rating, interrupting capacity when greater than 10,000 Amperes and current limiting where it applies, and the name of the trademark of the manufacturer.
2. Interrupting Capacity: Each fuse shall be capable of safely interrupting the maximum short-circuit current available at the point in the circuit where installed.
3. Coordination: Service fuses and the fuses installed in feeder circuits shall be coordinated to provide a selective system of over-current protection.

C. Main, feeder, and branch circuit fuses shall be as follows:

1. Circuits 0 to 600 amperes shall be protected by BUSSMANN Low-Peak, Limitron, or Fusetron (RK5, 200,000 I/C) Fuses rated as indicated on the drawings.
2. Motor Circuits: All motors rated 480 volts or less shall be protected by dual-element fuses rated not in excess of 175% and not less than 125% of motor nameplate rating or as indicated. Larger motors as indicated on drawings where fuse gaps are larger than size required for proper rating of fuse, install "all-metal" fuse reducers.

2.6 LABELING

- A. Label all disconnect switches, panelboards, and transformers provided under Division 26 of these Specifications.
- B. Labels shall be machine engraved, laminated, Bakelite, nameplate type. Labels shall have black faces with white letters.
- C. Size of labels shall be based on the required lettering and lettering size. The following are the minimum requirements for each type of label:
 1. Panelboards and Transformers: The First line of label shall state name of panel as shown on the drawings. The Second line shall state from where the panel is fed. Lettering shall be 3/8" high.

Example:	Panel L-100	Transformer TC-1
	Fed from MDS	Fed From Panel #1
	Circuit # _____	Circuit # _____
	Voltage _____	Voltage _____

2. HVAC equipment with integral disconnects shall be labeled on the outside of the equipment housing at the location of the disconnect in the same manner as Motor Controllers. The HVAC equipment shall be labeled in 1/4" high letters. First line shall state the name of the equipment as it appears on the electrical drawings. Second line shall state from what panel the equipment is fed.

Example:	Roof Top Unit No. RTU-2
	Fed from Panel 100
	Circuit # _____
	Voltage _____

3. Disconnect Switches: Disconnect switches shall be labeled in 1/4" high letters. The First line shall state what the switch/contactors is feeding. The Second line shall state from which circuit and panel the switch/contactors/time clock is fed.
- D. Circuit breakers serving Fire Alarm Control Panels shall be provided with a red, Bakelite nameplate with white letters attached to the panel adjacent to the circuit breaker.
- E. Attach labels with a minimum of two rivets or sheet metal screws. Adhesive-backed labeling will not be accepted.
- F. Workspace indication for all electrical equipment (Panelboards, and Transformers): Provide 3" wide, 5 mil floor marking safety vinyl tape (striped black and yellow) to show working clearances in the direction of access to live parts. Working clearance around equipment shall not be less than those listed in the N.E.C, Article 110.26 for all voltages specified. Do not install in front of flush-mounted or surface-mounted panelboards and similar equipment in finished spaces, unless directed by the owner.

2.7 PULL BOXES

- A. Install pull boxes at all necessary points, whether indicated on the drawings or not, to prevent injury to conductor insulation or other damage that might result from pulling resistance or for other reasons necessary for proper installation. Minimum dimensions shall not be less than the NEC requirements and shall be increased if necessary for practical reasons or where required to fit the job condition.
- B. Above grade pull boxes shall be constructed of galvanized sheet steel, code gauge, except that not less than 12-gauge shall be used for any box. Where boxes are used in connection with exposed conduit, plain covers attached to the box with a suitable number of countersunk flathead machine screws may be used.
- C. All junction and pull box covers shall be labeled indicating the circuits contained therein in a manner that will prevent unintentional interference with circuits during testing and servicing. For example: "HE1-13." See Specification Section 260534 for additional labeling requirements.

2.8 DISCONNECT SWITCHES

- A. Disconnect switches shall conform to governing industry NEMA standards. They shall be listed by UL. Disconnect switches shall be NEMA standard HD, quick-make, quick-break type, and capable of being locked in the off position.
- B. Where disconnect switches are indicated or required by the NEC to be weatherproof, furnish NEMA 3R enclosures.
- C. Arc Flash Warning Labels: Provide all disconnect switches provided by this project with Arc Flash warning labels on the exterior of the switch.

2.9 BRANCH CIRCUITS

- A. The branch circuit wiring has been designed to utilize the advantages of multi-wire distribution and shall be installed substantially as indicated on the drawings. Major changes in the grouping or general routing of the branch circuits require prior approval in writing from the Architect/Engineer.
- B. The number of conductors in each run of conduit is indicated on the drawings, but where there is a conflict between the number of wires indicated and the actual number required as determined by the functional requirements of the connected load, or where the number of wires was inadvertently omitted from the drawings, the correct number and size of wires as determined by the functional requirements of the connected load shall govern and be provided at no additional cost.
- C. Where individual 120V or 277V homerun circuits are shown on the drawings, they may be combined as follows:
 - 1. No more than three phase conductors plus three neutrals and one ground per conduit.
 - 2. No two of the same phase conductor per conduit.
 - 3. Provide 120V circuits with individual neutrals per circuit. Neutrals may not be shared.
 - 4. Neutral sharing by 277V circuits is acceptable.

2.10 MOTOR AND CONTROLLER DISCONNECTING MEANS

- A. Provide a disconnecting means for each motor, where indicated on the drawings. A circuit breaker in a panelboard, horsepower rated switch, or type specified under Article 430 and 440 of the NEC will be acceptable as a disconnecting means, if readily accessible and if located within sight of the motor and in compliance with all codes. A quick-make and quick-break general use tumbler or snap switch will be acceptable for capacities of 20 amperes or less and 300 volts and less, provided the ampere rating of the switch is at least double the rating of the equipment controlled. Switches of 30- to 400-ampere capacity shall be of the enclosed, quick-make and quick-break type, heavy duty, horsepower rated. Switches shall disconnect all ungrounded conductors and shall disconnect grounded conductors if required by the NEC or if called out on the drawings to do so. Switches shall be fusible type where indicated on the drawings.

2.11 CABLE TIES

- A. Provide cable ties in the length required. Standard, indoor cable ties shall be 7.9 inches in length minimum, 0.19 inches in width and 0.47 inches thick. The tensile strength shall be 50 pounds minimum and the maximum bundle diameter shall be 2 inches. Standard cable ties shall be black in color. Plenum rated cable ties shall be 6 inches in length minimum, .075 inches in width and 0.1 inches thick. The tensile strength shall be 50 pounds minimum and the maximum bundle diameter shall be 1.5 inches. Plenum rated cable ties shall be maroon in color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install material in a first-class and workmanlike manner to the satisfaction of the Engineer.

END OF SECTION 260500

SECTION 260519 - CONDUCTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

- A. Feeder and branch circuit wiring shall conform to the requirements of the NEC, and shall meet all relevant ASTM specifications.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer for a complete installation and for the application indicated. Provide copper conductors with a conductivity of not less than 98% at a temperature of 20°C (68°F).
- B. Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by installer to comply with project's installation requirements, the NEC, and NEMA standards. Select from the following UL types those wires with construction features which fulfill project requirements:
 - 1. Type 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.
 - 2. 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. Unless specified otherwise, power conductors shall be 600 volt, Type THWN/THHN, or XHHW.
- D. Conductors shall be continuous from outlet to outlet with splices made only in pull boxes, junction boxes, and outlet boxes.
- E. Do not use wire smaller than #12 AWG for power or lighting wiring.

- F. Wiring sizes #12 and #10 AWG shall be solid. Larger sizes may be stranded.
- G. Neutral conductors shall not be under sized.

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 compression crimp (butt-splice) connectors, Scotch Brand tape No.33 and 3M Brand cold shrink splice insulators.
- E. All branch circuits, feeders, and control wiring or cables of any type shall be color coded to identify the voltage and phase. The color shall be integral with the Insulation for sizes #12, #10, and #8 AWG. Larger size wire and cable shall be color coded with a minimum 1/2" wide, colored, plastic tape strip. Place strips a minimum of 6" on center anywhere the conductors are accessible and visible. Wire and cable shall be color coded to match the existing color coding if an existing color code is present. If there is no existing color code, provide the following:

<u>120/208-Volt System</u>	<u>277/480-Volt System</u>
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. Submit the results of the insulation resistance tests to the Architect/ Engineer for approval. Provide readings for each circuit tested indicating the points between which the circuit was tested, reading, date and time of test, and name of the individual performing the test.
- I. Advise the Architect/Engineer in writing of the tests five (5) working days prior to the date the testing is to commence.
- J. Advise the Engineer if the color-coding provided by the utility company differs from that indicated above.

3.2 TEMPORARY WIRING

- A. Temporary wiring is not specified nor governed by this Division of the Specifications.

END OF SECTION 260519

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

- A. Provide grounding for conduits, motor frames, metal casings, receptacles, and solid neutral, and as required by NEC Article 250.

PART 2 - PRODUCTS

2.1 GROUND WIRE

- A. Provide a green insulated ground wire, sized per the NEC, in all conduits, junction boxes, and pull boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Connect grounding conductors to the panelboard equipment ground bus and not to the panelboard neutral bus. Also connect grounding bushings to the ground bus. Connect the neutral bus only to the system neutral wire. Provide a bonding wire between the equipment ground bus and the neutral bus in the main distribution equipment only. The grounding system (conduit, cabinets, enclosures, and grounding conductors) and the grounded system (neutral conductors and service equipment ground) shall be separate and independent systems, except at the main distribution equipment.
- B. Test resistance to ground and submit readings to the Engineer for review. Include the date and time of the test and the name of the individual performing the test.

END OF SECTION 260526

SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

- A. Extent of supports, anchors, sleeves, and seals is indicated in other Division 26 Sections.
- B. Types of supports, anchors, sleeves, and seals specified in this Section include the following:
 - C-clamps
 - I-beam clamps
 - One-hole conduit straps
 - Two-hole conduit straps
 - Round steel rods
 - Expansion anchors
 - Toggle bolts
 - Wall and floor seals
 - Minerallac Straps
 - 2-Piece Strutt Straps
 - Slotted Channel
 - Cable Ties
- C. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 26 Sections.

1.3 QUALITY ASSURANCE

- A. Furnish supporting devices manufactured by firms regularly engaged in manufacture of supporting devices of types, sizes, and ratings required.
- B. Comply with the requirements of the NEC, as applicable to construction and installation of electrical supporting devices.
- C. Comply with applicable requirements of ANSI/NEMA FB1, "Fittings and Supports for Conduit and Cable Assemblies."
- D. Comply with NECA "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

- E. Provide electrical components which are UL-Listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES

- A. Provide supporting devices complying with manufacturer's standard materials, design, and construction in accordance with published product information and as required for a complete installation, and as herein specified. Where more than one type of device meets indicated requirements, selection is installer's option.
- B. Provide supporting devices of types, sizes, and materials required, and having the following construction features:
1. Reducing Couplings: Steel rod reducing coupling, 1/2" by 5/8"; galvanized steel; approx. 16 pounds per 100 units.
 2. C-Clamps: Galvanized steel; 1/2" rod size; approx. 70 pounds per 100 units.
 3. I-Beam Clamps: Galvanized steel, 1-1/4" by 3/16" stock; 3/8" cross bolt; flange width 2"; approx. 52 pounds per 100 units.
 4. One-hole Conduit Straps: For supporting metal conduit through 3/4" galvanized steel; approx. 7 pounds per 100 units.
 5. Two-hole Conduit Straps: For supporting metal conduit above 3/4" galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
 6. Hexagon Nuts: For 1/2" rod size; galvanized steel; approx. 4 pounds per 100 units.
 7. Round Steel Rod: Galvanized steel; 1/4" dia.; approx. 12.2 pounds per 100 feet, 3/8" dia.; approx. 29.3 pounds per 100 feet, 1/2" dia.; approx. 67 pounds per 100 feet.
 8. Offset Conduit Clamps: For supporting 2" rigid metal conduit; galvanized steel; approx. 200 pounds per 100 units.
 9. 2-Piece strut strap, appropriate size, and type for type of conduit being installed. 1-piece straps are prohibited.
 10. Minerallac straps sized appropriately for the conduit installed. Drilling out the attachment hole is prohibited. Use proper size hardware for attachment per the UL listing.
 11. 7/8" and 1 3/4" slotted channel shall be sized appropriately per the manufacturer's specifications for weight distribution. All feeder conduit racks shall be 1 3/4" minimum.
 12. Cable ties shall be Type 2S and 21S. Install in accordance with Section 330.30(A) of the NEC.
- C. Provide anchors of types, sizes, and materials required and having the following construction features:
1. Expansion Anchors: 1/2"; approx. 38 pounds per 100 units.
 2. Toggle Bolts: Springhead; 3/16" by 4"; approx. 5 pounds per 100 units.
 3. Concrete anchors: Anchors used for attaching 1/4" rod shall be Hangermate one-piece Concrete screw with internal threads or equal. Follow manufacturers installation specifications for proper installation.
 4. Concrete Anchors: Anchors used for attaching 3/8" and 1/2" rod shall Lok Bolt Sleeve anchor type Dewalt 05815S-PWR and 05825S-PWR or approved equal. Follow

- manufacturers technical Data for weight limitations and installation specifications for proper installation.
5. Drop-in type anchors shall be used only in vertical concrete walls. Hollow wall anchors shall be used in hollow CMU walls. Anchor shall be installed with manufacturer approved set tool.
- D. Provide sleeves and seals of types, sizes, and materials required, and having the following construction features:
1. Provide factory-assembled, watertight wall and floor seals suitable for sealing around conduit, pipe or tubing passing through concrete floors and concrete block walls. Construct with steel sleeves, malleable-iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps and cap screws.
- E. Provide U-channel strut system for supporting electrical equipment, 16-gauge hot-dip galvanized steel of sizes required; construct with 9/16" dia. holes, 8" o.c. on top surface, and with the following fittings which mate and match with U-channel:
- Fixture hangers
 - Channel hangers
 - End caps
 - Beam clamps
 - Wiring stud
 - Rigid conduit clamps
 - Conduit hangers
 - U-bolts

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES

- A. Install hangers, anchors, sleeves, and seals as indicated in accordance with manufacturer's published instructions and with recognized industry practices to ensure supporting devices comply with the requirements of the NEC, NECA, and ANSI/NEMA for installation of supporting devices.
- B. Coordinate with other electrical work, including outlet box, raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Install hangers, supports, clamps, and attachments to support conduit and outlet boxes properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze-type hangers where possible. Install supports with maximum spacings indicated.
- D. Tighten sleeve seal nuts until sealing grommets have expanded to form watertight seal.

END OF SECTION 260529

SECTION 260533 - RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

- A. Run all conduit concealed, except conduit may be run exposed in mechanical rooms, locations where specifically indicated, and spaces with exposed construction as approved by the Engineer.
- B. Provide a conduit system complete with fittings and hangers as specified herein and as required by the NEC. Run all electrical wiring systems above 24 Volts in conduit unless specifically indicated otherwise.
- C. Install conduit as a complete system without wiring and continuous from outlet to outlet and from fitting to fitting, mechanically and electrically connected to all boxes, fittings, and wireways, and grounded in accordance with the NEC.
- D. Cap ends of all conduit promptly upon installation with plastic pipe caps. Caps shall remain until wiring is ready to be installed. Taping the ends of conduits is not acceptable.
- E. Size conduit to equal or exceed the minimum requirements of the NEC (except where sizes are specifically indicated on the drawings and in these specifications).
- F. Verify exact swing of doors, prior to installing conduit for switches. Coordinate switches with the Architect's plans, change orders, addenda, and job site differences and make the necessary adjustments to avoid conflicts at no additional cost.
- G. Coordinate the routing of conduit with other trades to avoid conflicts with structural members, piping, ductwork, and other job site conditions.
- H. When PVC conduit is used below grade, it shall be glued together in such a manner so as to make it watertight.

PART 2 - PRODUCTS

2.1 CONDUIT

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- A. Minimum size conduit shall be 1/2" unless noted or indicated otherwise on drawings. 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.
- 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, 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 outdoors shall be plastic covered. The maximum length for flexible conduit is 72" unless as otherwise indicated. Liquid tight flexible metal conduit is prohibited where subject to physical damage and areas where ambient and conductor temperature exceed the approved operating temperature. Cable ties used to support LFMC shall be type 2S or 21S.
- F. Conduit may not be run in the flutes of metal roof decking and may not be attached to any part of metal roof decking.
- G. Bury conduit run below grade a minimum of 24" below finished grade or so the top of the conduit is 6" below the bottom of the concrete slab if run underneath concrete unless indicated or required to be deeper. Increase the burial depth as required so that no part of the conduit radius is within the concrete slab where conduits turn vertical. Coordinate conduit routings and depths with all other trades and 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 bus.

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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install conduit concealed in walls, 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.

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- E. Securely fasten conduit to outlets, junction boxes, and pull boxes to affect firm electrical contact. Join conduit with approved couplings. Running threads are not allowed.
- F. Exercise care to avoid condensation pockets in the installations. Keep conduit, fittings, and boxes free from foreign matter of any kind, before, during, and after installation.
- G. Do not use EMT below grade, outdoors and in wet locations.
- H. Support exposed runs of conduit in accordance with N.E.C. 342, 344, 348, 350 and 358 and parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings with right angle turns consisting of fittings or symmetrical bends. Support conduit within one foot of all changes in direction and on each side of the change.
- I. Supports shall be wall brackets, trapeze, strap hanger, or pipe straps, secured to hollow masonry with toggle bolts or Hollow wall anchors; to brick and concrete with expansion Anchors; to metal surfaces with machine screws; and to wood with wood screws. Overhead conduits supported by threaded rod from concrete shall be those listed in the approved hanger specification and conform to the manufactures technical data and installation specifications.
- J. Use explosive drive equipment to make connections where the use of this equipment is beneficial, and is subject to strict compliance with safety regulations and approved by the Owner.
- K. Wooden plugs inserted in masonry and the use of nails as fastening media are prohibited.
- L. Do not support conduit from lay in tile ceilings grids, ceiling grid hangers, or lay on ceiling tiles.
- M. Prime conduit with a surface conditioner "GalvaGrip" or approved equal and paint to match the surface on which attached. Conduit installed in mechanical and electrical rooms need not be painted.
- N. Install and support conduit from the underside of the upper chord in bar joist construction.
- O. Do not support conduit from or attach outlet or junction boxes to metal roof decks.
- P. Do not run conduit in the cavity of exterior walls between brick and CMU.
- Q. Seal openings in floors where conduits penetrate vertically through with a clear silicon sealant to prevent liquids and insects from passing through.
- R. Where conduits penetrate vertically through fire-rated floors, or walls seal the conduits with a UL-Listed, water-resistant firestop material with a rating equal to or greater than the rating of the penetrated floors.
- S. Metal conduit installed in earth shall be painted with two coats of bitumastic paint.
- T. All conduit runs entering the building from outdoors shall be sealed against moisture migration and condensation by filling with insulating type foam.

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- U. Single runs of conduit $\frac{1}{2}$ " to $1\frac{1}{2}$ " in diameter shall be supported by $\frac{1}{4}$ " round galvanized rod. Single runs of conduit 2" and larger shall be supported by $\frac{3}{8}$ " round galvanized rod. Single tier conduit racks with conduit $\frac{1}{2}$ " to 1" and no greater than five shall be supported by $\frac{1}{4}$ " round galvanized rod. Single tier conduits racks $1\frac{1}{4}$ " and larger shall be supported with $\frac{3}{8}$ " round galvanized rod. All conduit racks larger than a single tier shall be $\frac{1}{2}$ " minimum round galvanize rod. Conduit and conduit racks shall comply with the manufacturer's supporting limitations.

END OF SECTION 260533

SECTION 260534 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

- A. Furnish and install all junction boxes of a type and size applicable for use in the location indicated on the drawings and where required by the NEC.
- B. Exercise special care in the location of outlet and junction boxes in order that the hanging or recessing of light fixtures will not be obstructed by piping or ductwork installed by other trades. To this end, coordinate the work with representatives of the other trades involved and by reference to the structural and mechanical drawings.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

- A. Outlet boxes shall be sheet steel, zinc coated, or cadmium plated.
- B. Provide existing and new outlet boxes installed but not used, including data outlets, with blank coverplates matching those provided on adjacent outlets.
- C. Size boxes as follows:
 - 1. Receptacle Outlet Boxes: Provide single gang outlet boxes 1-1/2" deep unless required to be larger. Provide extra deep boxes where required.
- D. Provide boxes located above suspended ceilings with galvanized steel covers, with openings or knockouts as required for type of service.

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, worktables, etc., that exist or will be installed. Make necessary adjustments in the location of wall outlets to avoid conflicts as approved by the Architect and at no additional cost to the Owner.
- E. Prior to roughing-in conduit, coordinate with other trades and the Owner regarding all equipment requiring electrical connections. Required adjustments to the conduit and wire sizes shall be made at no additional cost.
- F. Conduit installation shall be rigid and secure, and, where necessary, angle iron (1" by 1" by 1/4" or larger) shall be provided to facilitate adequate mounting.
- G. Install electrical boxes and fittings in accordance with manufacturer's published instructions, applicable requirements of the NEC and NECA "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- H. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- I. Provide "weatherproof-while-in-use" rated outlet covers for interior and exterior locations exposed to weather or moisture.

- J. Provide knockout closures to cap unused knockout holes where blanks have been removed in panel cans, terminal cabinet backboxes, junction boxes, outlet boxes and pull boxes.
- K. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- L. Do not install boxes back to back in walls. Provide not less than 6" (150 mm) separation. Thru-the-wall boxes may not be used.
- M. Position recessed outlet boxes accurately to allow for surface finish thickness.
- N. Set floor boxes level and flush with finish flooring material.
- O. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached or solidly embed electrical boxes in concrete or masonry.
- P. Subsequent to installation of boxes, protect boxes from construction debris and damage.
- Q. Upon completion of installation work, properly ground all electrical boxes.
- R. Do not mount boxes to metal roof decking.

END OF SECTION 260534

SECTION 262200 - DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

- A. Extent of transformer work is indicated by drawings and schedules.
- B. Types of transformers specified in this Section include general-purpose dry-type transformers.
- C. Electrical wiring connections for transformers are specified in applicable Division 26 Sections.

1.3 QUALITY ASSURANCE

- A. Comply with the requirements of the NEC, as applicable to installation and construction of electrical power distribution transformers.
- B. Comply with applicable portions of NEMA TR1 and DOE 2016 minimum Standards for power distribution transformers.
- C. Comply with applicable requirements of ANSI C57-Series pertaining to power distribution transformers.
- D. Comply with requirements of NEMA ST20, "Dry-type Transformers for General Applications".
- E. Comply with applicable requirements of ANSI/UL 506, "Safety Standard for Specialty Transformers." Provide power distribution transformers and components which are UL-Listed and labeled.
- F. Comply with applicable requirements of NESC (ANSI C2) pertaining to indoor and outdoor installation of transformers.

PART 2 - PRODUCTS

2.1 POWER DISTRIBUTION TRANSFORMERS

- A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation. All transformers shall be products of a single manufacturer.
- B. Dry-type Distribution Transformers: Provide factory-assembled, general-purpose, and DOE 2016 compliant and, air-cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated; 3-phase; 60 Hz, 30kV BIL, 4.0% nominal impedance, copper windings, with 480-Volts delta connection primary and 208/120-Volts secondary wye connected. Provide primary winding with six 2-1/2% taps; two above and four below primary rated voltage. Transformers 15kVA and above shall be rated for 150°C temperature rise above 40°C ambient. All insulating materials shall be in accordance with NEMA ST20 Standard for a 220°C UL component recognized insulation system. Limit transformer surface temperature rise to maximum of 65°C. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Provide wiring connectors suitable for copper wiring. Sound levels shall not exceed the following: 15 to 50kVA = 45 dB. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards. Provide transformers with fully enclosed sheet-steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for floor or wall mounting as indicated. The transformers shall be listed by UL for the specified temperature rise.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which power distribution transformers and ancillary equipment are to be installed and notify the General Contractor, in writing, of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TRANSFORMERS

- A. Install transformers as indicated, complying with manufacturer's published instructions (including rear ventilation clearances), applicable requirements of the NEC, NESC, NEMA, ANSI, DOE and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Connect transformer units to electrical wiring system; comply with requirements of other Division 26 Sections.

- D. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.
- E. Provide 4" thick concrete housekeeping pad under all transformers. Exceed dimensions of transformer by 6" on all sides. Chamfer all exposed edges 1/2".
- F. Keep transformers clean and free from foreign matter of any kind, before, during, and after installation.
- G. Provide sufficient space around transformer for cooling as recommended by the manufacturer. Provide a minimum space of 8" between the transformer and any wall.

3.3 GROUNDING

- A. Provide equipment grounding connections for power distribution transformers as indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

3.4 TESTING

- A. Prior to energization of transformers, check all accessible connections for compliance with manufacturer's torque tightening specifications.
- B. Prior to energization, check circuitry for electrical continuity and for short-circuits. After all wiring is pulled and ready for operation but prior to placing systems in service, conduct insulation resistance tests in all feeder circuits. Measure the insulation resistance between conductors and between each conductor and ground. Make measurements with an instrument capable of making measurements at an applied potential of 500 Volts.
- C. Upon completion of installation of transformers, energize primary circuitry at rated voltage and frequency from normal power source and test transformers, including but not limited to audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units or components and proceed with retesting.
- D. Infrared Scanning: After Substantial Completion, but not more than 60 days from Final Acceptance, perform an infrared scan of each transformer.
 - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2. Record of Infrared Scanning: Prepare a certified report that identifies transformer checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

- A. Extent of panelboard, load center, and enclosure work, including cabinets and cutout boxes, is indicated by drawings and schedules.
- B. Refer to other Division 26 Sections for cable/wire, connectors, and electrical raceway work required in conjunction with panelboards and enclosures; not work of this Section.

1.3 QUALITY ASSURANCE

- A. Comply with the requirements of the NEC, as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with the NEC requirements pertaining to installation of wiring and equipment in hazardous locations.
- B. Comply with applicable requirements of UL 67, "Electric Panelboards," and UL 50, UL 869, UL 486A, UL 486B, and UL 1053 pertaining to panelboards, accessories, and enclosures. Provide units which are UL-Listed and labeled.
- C. Comply with NEMA 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," and NEMA PB1, "Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less."

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with the NEC, UL, and established industry standards for those applications indicated. Series rating is not acceptable for circuit breakers serving life safety equipment.

- B. Provide dead-front, safety-type, power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types, and arrangement shown; with mechanical type conductor connectors for Main, Neutral, and Ground lugs approve for copper or aluminum conductors. Specific circuit breaker placement is required in panelboards to match the circuit breaker placement indicated in the panelboard schedule on the drawings. Equip with copper busbars with not less than 98% conductivity and with neutral bus. Provide suitable lugs on neutral bus for outgoing circuits requiring neutral connections. Provide bolt-on molded-case main and branch circuit breaker types for each circuit, with toggle handles that indicate when tripped. Where multiple-pole circuit breakers are indicated, provide with common trip so an overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate properly with panelboards. Branch mounted main circuit breakers are not acceptable. Provide bottom mounted main circuit breakers for panelboards fed from below. Provide top mounted main circuit breakers for panelboards fed from above. All spaces shall have bus fully extended and drilled for the future installation of breakers.
- C. Provide galvanized sheet-steel cabinet-type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush locks and keys. All panelboard enclosures shall be keyed alike. Equip with interior circuit directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for flush mounting unless otherwise indicated. Provide enclosures which mate properly with panelboards to be enclosed.
- D. Provide panelboard accessories and devices, including but not necessarily limited to circuit breakers and ground-fault protection units, as recommended by panelboard manufacturer for ratings and applications indicated. Circuit breakers serving permanently connected appliances rated over 300 volt-amperes shall be capable of being locked in the "OFF" position. Provide HACR rated circuit breakers for all heating and air conditioning equipment.
- E. Provide panelboards UL Service Entrance rated when required.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which panelboards and enclosures are to be installed, and notify the General Contractor, in writing, of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Install panelboards and enclosures as indicated, in accordance with manufacturer's published instructions, applicable requirements of the NEC and NECA "Standard of Installation," and in compliance with recognized industry practices to ensure that products fulfill requirements.
- C. Coordinate installation of panelboards and enclosures with raceway installation work.

- D. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.
- E. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
- F. Provide properly wired electrical connections within enclosures.
- G. Provide a typed circuit index card for each panelboard upon completion of installation work. Indicate load served and room number(s). Use final room numbers obtained from the Architect or Owner, not construction room numbers as shown on the drawings.

3.2 GROUNDING

- A. Provide equipment grounding connections for all panelboards. Tighten connections to comply with tightening torques specified in UL 486A and UL 486B to assure permanent and effective grounding.

3.3 FIELD QUALITY CONTROL

- A. Keep panelboards clean and free from foreign matter of any kind, before, during, and after installation.
- B. Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.
- C. Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- D. Prior to energization, check panelboards for electrical continuity of circuits and for short-circuits.
- E. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.
- F. Infrared Scanning: After Substantial Completion, but not more than 60 days from Final Acceptance, perform an infrared scan of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
 - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

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2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

SECTION 262420 - MOTORS AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.

1.2 SCOPE OF WORK

- A. Furnish and install disconnect switches as indicated on the drawings and specified herein.
- B. Provide all power wiring, disconnect switches and electrical connections to all equipment provided and requiring electrical connections. Starters and/or magnetic contactors; 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 serving a piece of mechanical equipment shall be provided by Division 23 Contractor and installed in accordance with the requirements of Division 26, unless otherwise indicated on the electrical drawings or in the electrical specifications.
- D. Review the mechanical drawings and specification sections for exhaust fans requiring control by wall switch, solid state speed controller, or line voltage thermostat and provide same where indicated on the electrical drawings.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Disconnect switches shall be rated for the voltage of the equipment being served with number of poles and current rating as indicated. Disconnect switches shall be non-fusible or fusible type as indicated on the drawings.
- B. Switches shall be NEMA standard Heavy Duty type.
- C. Switches shall be horsepower rated when used for motor disconnect means.

- D. Provide fused disconnect switches complete with appropriately sized fuses for the circuits controlled.

PART 3 - EXECUTION

3.1 INSTALLATION OF DISCONNECT SWITCHES

- A. Examine area and conditions under which electrical connections for equipment are to be installed. Notify the General Contractor; in writing; of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Coordinate locations of disconnect switches with the locations of mechanical equipment, piping, electrical equipment and any and all other building elements such that all NEC requirements, including working clearances, are met. Adjust locations from those shown on the drawings as required to comply with NEC working clearance requirements at no additional cost to the project.
- C. Secure disconnects switches to building elements or equipment housings where indicated on the drawings. Where building walls or equipment housings do not provide suitable mounting surfaces, provide a galvanized unistrut frame or rack satisfactory in size to securely support the disconnect switch, magnetic contactor and /or VFD. Where racks are required to be roof mounted, secure the rack to the roof in a method that does not compromise the roof membrane in any way. Submit the roof attachment method to the 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:
 - Ground-fault circuit interrupters
 - Cover plates
- 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. 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. 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 torqueing 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.
- I. Install grounded conductors at the location of switches per the requirements of NEC Article 404.
- J. Switches that are combined in the same enclosure that exceed 300 volts are prohibited.

- K. Receptacle that are used during construction after permanent power is energized shall be replaced at the final completion of the project.

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. The proper outlet testing equipment shall be used to test receptacles.

END OF SECTION 262726

SECTION 263213 - DIESEL ENGINE-GENERATOR

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 260100, "Electrical General Provisions, and Section 033000 "Cast-In-Place Concrete", apply to this Section.

1.2 SCOPE OF WORK

- A. Provide a diesel engine-generator set of the latest commercial type and design.

1.3 MATERIALS

- A. The supplier shall furnish:
 - 1. A 300 KW Standby rated diesel Engine-Generator set, along with accessories, per this Specification. GENERAC POWER SYSTEMS Model SD300, or approved equal.
 - 2. Startup, testing, and Owner training as specified herein.
 - 3. Labor to test the generator with reactive load banks upon completion of wiring.
 - 4. Generators by CATERPILLAR, CUMMINS, KOHLER and MTU are considered equal provided all requirements of this specification are met or exceeded.
 - 5. Generator and associated enclosure shall be listed in accordance with UL 2200.
 - 6. Generator shall be NFPA 110, Level 1, Class 72, and Type 10 compliance.

1.4 MANUFACTURER

- A. The engine and generator shall be the product of one manufacturer who has been regularly engaged in the design and production of engine-generator sets for a minimum of 10 years.

1.5 SUPPLIER

- A. It is essential that the engine-generator supplier maintain a local parts and service facility within 100 miles of this installation. The supplier must carry sufficient inventory to cover no less than 90% parts service within 24 hours and 95% within 48 hours. Further, the supplier shall have factory-trained service representatives to furnish all installation, test, and start-up supervision necessary for final approval and acceptance as well as perform maintenance and repairs on all components as required.

1.6 POWER RATING

- A. Power rating of the diesel engine-generator set shall be based on operation at rated rpm when equipped with all necessary operating accessories, such as air cleaners, lubricating oil pump, fuel transfer pump, fuel injection pumps, jacket water pump, governor, alternating current generator, and exciter regulator. The radiator fan shall be included as necessary operating accessory. Rating shall apply at site conditions of 100 feet above sea level and 100°F ambient air temperature.

1.7 TESTING AND STARTUP

- A. Unit shall be factory performance tested at rated kW before shipping. Paperwork shall be provided to the Engineer upon request.
- B. Prior to acceptance of the equipment, the unit shall be tested at full rated load through the use of vendor-supplied load banks. The test shall be performed at the job site and must prove that the engine-generator set is free of any defects and will perform to these Specifications. All consumables, including fuel, necessary for the test shall be furnished by the supplier. Block loading (25%, 50%, 75%, and 100% loads) shall be done in the presence of the Owner's Engineer or his appointed representative and shall be for a period of 4 hours, one hour at each of the levels, transient responses, including voltage dips, frequency dips, and recovery time period, shall be measured and agree with the data submitted with the bid. Test Reports will be furnished for approval upon completion of the test.
- C. Factory authorized startup shall include but not be limited to verifying that all safety shutdowns are functioning properly.
- D. Fuel: On completion of the installation and testing, the base fuel tank shall be filled to capacity.

1.8 SUBMITTAL DATA

- A. Make and model of engine-generator.
- B. Makes and models of switchgear and other major auxiliary equipment, including automatic transfer switch, vibration isolators, and radiator.
- C. Manufacturer-produced dimension drawings of the complete engine-generator set clearly showing entrance points for each of the interconnections required.
- D. Manufacturer-published kilowatt output curve and published fuel consumption curve.
- E. Unit ventilation and combustion air requirements.
- F. Manufacturer-published transient response data of the complete engine-generator set 100% block loads. Data shall include maximum voltage dips.

- G. Location and descriptions of the supplier's parts and service facilities within a 100-mile radius of the job site, including parts inventory and number of qualified engine-generator set service personnel.
- H. Actual electrical diagrams, including schematic diagrams and interconnection wiring diagrams for all equipment to be supplied.
- I. Manufacturer warranty statements.
- J. Generator motor starting curves showing the voltage dip versus starting KVA.
- K. Submit Automatic Transfer Switch[es] shop drawings to Dominion Energy and gain approval on same prior to submitting to the Architect/Engineer.

PART 2 - PRODUCTS

2.1 ENGINE

- A. The engine shall be a minimum 6-cylinder turbo-charged, aftercooled, water-cooled, in-line, four-stroke cycle. Engines requiring premium fuel will not be permitted. The engine shall be a compression ignition diesel which meets Specifications when operating on No. 2 diesel fuel. The engine shall be equipped with fuel, lube oil, intake air filters, lube oil cooler, fuel transfer pump, service meter, gear-driven water pump, and instruments, water temperature gauge, lubricating oil pressure gauge, and battery charging ammeter.
- B. Governor: Engine governor shall be Electronic type which shall control the frequency within 3% of rated frequency from no load to full load for droop operation or isochronous frequency regulation when supplying electronic or other non-linear loads. The frequency of any constant load shall remain within a steady-state band width of $\pm 0.25\%$ of rated frequency.
- C. Mounting: The engine-generator set, including radiator, shall be mounted on a 36" tall maximum double-walled structural fuel tank base supplied by the engine manufacturer. Vibration isolators shall be provided between the engine and the fuel tank base.
- D. Protective Devices: Safety shutoffs for high water temperature, low oil pressure, electrical over-speed, engine over-crank, and low water level shall be provided.
- E. Enclosure: The generator shall be enclosed by a Series 2000 weather-protective enclosure fabricated of 14-gauge metal. The enclosure shall have a minimum of five hinged doors for access to the equipment. Doors shall be lift-off removable type with stainless-steel hinges and hardware. Proper intake and exhaust louvers shall be provided. Critical grade silencer must be enclosed within the unit. The enclosure shall be primed and painted with two coats of baked-on enamel paint. Enclosure color shall be tan.
- F. The generator shall be enclosed by an enclosure as listed above but with a sound attenuation rating of 85 dBA @ full load at 3 feet.

2.2 GENERATOR

- A. Rating: The generator shall be rated for standby electrical service as follows: 300 KW/375 KVA, 0.8 pf, 277/480 volts, 3-phase, 4-wire, Wye connected, 60 Hz, 1,800 rpm.
- B. Type: The generator shall be three-phase, single-bearing, synchronous type, permanent magnet excited, wet wound, tropicalized, and built to NEMA standards. Class F insulation shall be used on the stator and rotor, and both shall be further protected with an epoxy coating. The generator shall also include a resettable thermal protector and fuse for exciter/regulator protection against extended low power factor loads and faults. The generator rotor shall be dynamically balanced within 0.0005" peak-to-peak amplitude displacements at both ends of shaft and shall sustain 25% over-speed.
- C. Regulator: An automatic volts-per-Hz type, solid-state exciter/regulator, manufactured by the generator manufacturer, shall be included and shock mounted inside generator. Voltage regulation shall be $\pm 1/2\%$ from no load to full rated load. Readily accessible voltage drop, voltage level, and voltage gain controls shall be included in the module. Voltage level adjustment shall be a minimum of $\pm 10\%$. The module shall include the following protective features:
 - 1. Current limit circuits shall restrain the exciter field current while allowing full forcing voltage to be applied to obtain rapid response during transient conditions or service overloading on the generator.
 - 2. A time-delay circuit shall sense the current limit operation and cut off all field current to the generator after 10 seconds.
- D. Generator sets 15kw and larger shall have a name plate or manufacturer's instructions that contain the following information:
 - 1. Sub transient, transient, synchronous, and zero sequence reactance's.
 - 2. Power Rating Category
 - 3. Insulation system class
 - 4. Indication if the generator is protected against overload by inherent design, an overcurrent protected relay, circuit breaker or fuse.
 - 5. Maximum short-circuit current for inverter-based generator in lieu of the Sub transient, transient, synchronous, and zero sequence reactance's.

2.3 COOLING SYSTEM

- A. Radiator: An engine-mounted radiator with blower-type fan shall be provided to maintain safe operation at 122°F ambient temperature. Total airflow restriction to and from the radiator shall not exceed 0.5" H₂O (0.12 KPA).
- B. Cooling System Treatment: The engine cooling system shall be pre-treated by the engine supplier for the inhibition of internal corrosion. A solution of 50% ethylene glycol shall be added.

2.4 BASE FUEL TANK

- A. A double-walled, UL-142 Listed, NFPA 30 and 37 compliant, tank shall be provided for the unit sufficient in size to provide 72 hours of run time at full load. The tank shall incorporate threaded pipe connection and fuel gauge. A manual shutoff valve on the fuel line to the engine, and a drain valve shall also be included. A low-level alarm contact shall be wired to a low fuel level light on the generator control panel. The fuel tank shall be a maximum of 36" tall.
- B. Conform to NFPA 30 and 37. The unit shall contain its own fuel storage tank, filler and vent piping, flexible connections to engine, low fuel level alarm system. The main fuel pump on the engine shall be capable of supplying fuel directly from the storage tank without the need of any intermediate pump.

2.5 EXHAUST SILENCER

- A. A critical exhaust silencer and flexible stainless-steel bellows-type exhaust and rain cap fitting properly sized shall be furnished and installed on the generator enclosure. Silencer must be mounted inside the generator enclosure.
- B. Refer to the requirements of NFPA 37 regarding the location of the exhaust.

2.6 STARTING MOTOR

- A. The engine shall be equipped with a 12-volt electric starting system with positive engagement drive and of sufficient capacity to crank the engine at a speed which will start the engine under operating conditions. The starting pinion will disengage automatically when the engine starts.

2.7 AUTOMATIC CONTROLS

- A. Fully automatic generator set start-stop controls in the generator control panel shall be provided. Controls shall provide shutdown for low oil pressure, high water temperature, over-speed, over-crank, and one auxiliary contact for activating accessory items. Controls shall include cranking cycle without lockout and manual reset feature.

2.8 JACKET WATER HEATER

- A. An engine-mounted thermal circulation immersion water heater incorporating an adjustable thermostatic switch shall be furnished to maintain engine jacket water to 90°F (32.2°C). The heater shall be 120-volt, single-phase, 60 Hz.

2.9 BATTERY AND BATTERY CHARGER

- A. A lead/acid storage battery set of the heavy-duty diesel starting type shall be provided. Battery

voltage shall be compatible with the starting system. The battery set shall be rated no less than 110 ampere hours. A battery rack constructed in conformance with the NEC requirements and necessary cables and clamps shall be provided.

- B. Batteries shall be capable of cranking engine at rated ambient temperature of 10°F for 6-10 seconds without recharging.
- C. A current-limiting, float-equalize charger shall be installed inside the generator enclosure to automatically recharge batteries. The charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It should include overload protection, silicon diode full wave rectifiers, voltage surge suppressors, DC ammeter, and fused AC output, and battery malfunctions alarm relay. AC input voltage shall be 120 volts, single phase. Amperage output shall be no less than 10 amperes.

2.10 MAIN LINE CIRCUIT BREAKER

- A. Provide two main line molded case, three-pole, single-throw, static trip type circuit breakers rated 35 KAIC; 400 Amp Frame/350 Amp Trip amperes and 35 KAIC; 100 Amp Frame/100 Amp Trip amperes rated at 104°F (40°C) ambient temperature shall be installed for 3-phase overloads and/or short-circuit protection. This rating shall include at least 10% additional capacity for overload and operating temperature rise over 104°F (40°C). It shall operate both manually for normal switching functions and automatically during overload and short-circuit conditions.
- B. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short-circuit protection. The circuit breaker shall meet standards established by UL, NEMA, and the NEC.
- C. Generator/exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.

2.11 GENERATOR CONTROL PANEL

- A. Control panel shall be obtained from same manufacturer as generator set and shall include factory warranty and manufacturer's parts and service support.
- B. Generator-mounted Control Panel: Designed and built by the system manufacturer and incorporating 100% solid-state circuitry, sealed dust-tight, watertight modular components and instrumentation. The panel shall be shock mounted to the generator. It shall comply with IEC, IEC 144 IP22/NEMA 1 for external environmental resistance and IP44/NEMA 12 resistance for internal sealed modules. The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions, including engine protection, alternator protection, speed governing, voltage regulation, and all related generator operations. The generator controller must also provide seamless digital integration with the engine's electronic management system.

C. The control panel will display all user pertinent unit parameters, including:

1. Engine and alternator operating conditions
2. Oil pressure
3. Coolant temperature and level alarm
4. Engine speed
5. DC battery voltage
6. Run time hours
7. Generator voltages, amps, frequency, kilowatts, and power factor
8. Alarm status
9. Current alarm(s) condition per NFPA 110 level 1
10. Alarm log of last 20 alarm events (date and time stamped)

2.12 REMOTE ANNUNCIATOR PANEL

A. Provide NFPA 110, 16-Light, Level 1 remote annunciator panel shipped loose for contractor installation. The annunciator shall be provided with auxiliary contacts for monitoring by the building automation system. Provide 1" conduit with control cables between this remote annunciator panel and generator control panel. The annunciator shall have a visual and audible display of the NFPA 110 required functions including the following as a minimum:

1. Overcrank
2. Low coolant temperature
3. High coolant temperature warning
4. High coolant temperature shutdown
5. Low oil pressure warning
6. Low oil pressure shutdown
7. Overspeed
8. Low coolant level
9. EPS supplying load
10. Control switch not in auto
11. High battery voltage
12. Low battery voltage
13. Battery charger AC failure.
14. Emergency power off push button (EPO).
15. Spare.
16. Spare.

2.13 EMERGENCY POWER OFF PUSH BUTTON (EPO):

A. Provide a remote manual stop station with weatherproof stainless steel or die cast housing, red mushroom button - push to stop operation, breakable glass cover/lens with hammer to access mushroom button, 120-volt rated. The manufacturer shall provide automatic monitoring of the EPO switch. Placing the EPO switch in the "Generator Powered OFF" status shall initiate a visual and audible alarm at each generator remote annunciator panel.

2.14 CONCRETE PAD

- A. Provide 12-inch concrete pad, 3000 psi compression strength concrete reinforced with #4 rebar on 12-inch center, both directions, in center of pad. Set pad on 12" base of crusher-run stone. Exceed dimension of generator and sub-base fuel tank by 12" on all sides. Chamfer all exposed edges by 1/2 inch.
- B. All conduit entering the slab shall be vertical and at a 90° angle with the top of slab. Stub up all conduits 1 inch above top of the concrete pad. Provide all spare conduits with pull wire and plastic caps.
- C. Bond grounding rod to rebar in the slab and to generator frame. Stub rod up 6 inches above the top of the concrete pad. Size bond in accordance with NEC Article 250.66 requirements. Provide braided, bare copper bond cable from ground bar to pad reinforcing, and to frame. Leave sufficient slack above pad to tie to the generator frame, minimum of 24-inch coil.
- D. The contractor shall review generator installation instructions before forming the conduit stub up area.
- E. Refer to specification section 033000 "Cast-In-Place Concrete" for additional requirements.

2.15 WARRANTY

- A. Generator shall come with a manufacturer's 2-year warranty. A copy of this warranty shall be included in the submittal package.

PART 3 - EXECUTION

3.1 AFTER PRODUCT SUPPORT

- A. Instructions: On completion of the installation, three (3) O&M Manuals, including parts covering the engine, generator, and major auxiliary equipment shall be provided to the Owner. Training on operating and maintenance of the standby power systems shall be provided to operating personnel. This scheduled training session shall consist of one 8-hour day for a maximum of eight of the Owner's personnel and shall be performed by a trainer qualified by the manufacturer.

END OF SECTION 263213

SECTION 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SCOPE

- A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings.

1.2 RELATED SECTIONS

- A. Section 262416 – Panelboards

1.3 REFERENCES

- A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 latest addition).

1.4 SUBMITTALS – FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Engineer:
 - 1. Provide verification that the SPD complies with the required ANSI/UL 1449 Latest Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
 - 2. Electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- B. Where applicable the following additional information shall be submitted to the engineer:
 - 1. Descriptive bulletins
 - 2. Product sheets

1.5 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.7 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 - PRODUCTS

2.1 VOLTAGE SURGE SUPPRESSION – GENERAL

- A. Electrical Requirements:
 - 1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
 - 2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
 - 3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
 - 4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

Configuration	Protection Modes			
	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.
6. ANSI/UL 1449 Latest Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 Latest Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277
L-G; N-G	800	1200
L-L	1200	2000
L-N	900	1500

B. SPD Design:

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
 - a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
 - 1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
 - 2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
 - 3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator

lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

- b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
- c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
- d. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $50 \pm 20A$ occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
 - 1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection:

The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

8. Safety Requirements:

The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

- a. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.
- b. SPDs shall be factory sealed in order to prevent access to the inside of the unit. SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.2 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Main Service Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards)	120 kA	60 kA

- C. SPD Type – SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.3 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

- A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
 - 1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
 - 2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
 - 3. The panelboard shall be capable of re-energizing upon removal of the SPD.
 - 4. The SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
- B. Side mount Mounting Applications Installation (SPD mounted external to electrical assembly):

1. Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

2.4 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
 1. NEMA 1 – Constructed of steel intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects.
 2. NEMA 4 – Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure.
 3. NEMA 4X – Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

3.2 INSTALLATION

- A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.3 WARRANTY

- A. The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

END OF SECTION 264313