

**City of Milwaukee
Department of Public Works
Milwaukee Water Works**

**Specifications for
Official Notice No. 56-2012**

**HP-179 Administration Building - HVAC & Lighting Replacement
2012**



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GENERAL REQUIREMENTS

PART 1 DEPARTMENT OF PUBLIC WORKS – GENERAL SPECIFICATIONS

The Department of Public Works General Specifications applies to all contracts. These specifications are in a separate booklet.

PART 2 SPECIFIC OFFICIAL NOTICE AND GENERAL OFFICIAL NOTICE

The Specific Official Notice as it appears in The Daily Reporter and General Official Notice is part of these Contract Documents.

PART 3 SPECIFICATIONS

HP-179: Administration Building - HVAC & Lighting Replacement

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HP-179 ADMINISTRATION BUILDING HVAC & LIGHTING REPLACEMENT

JOB REQUIREMENTS

- JR-1 FORM OF BID Contractor shall submit a lump sum bid for furnishing the complete job in accordance with plans and specifications.
- JR-2 JOB LOCATION The water purification plant is located at 3929 South 6th Street, Milwaukee, WI 53221.
- JR-3 GENERAL DESCRIPTION OF WORK The work to be performed under the provisions of this contract and as set forth in these documents consists of the supply and installation of all materials, labor, supervision, inspection, and rentals for all work involved and described below.
- JR-4 CONTRACT DRAWINGS The contract drawings upon which the proposal is to be based are listed hereunder:

HP – 179-01	Location Map & Drawing Index
HP – 179-02	Basement Plan – Demolition
HP – 179-03	Ground Floor Plan – Demolition
HP – 179-04	Second Floor Plan – Demolition
HP – 179-05	Roof Plan – Demolition
HP – 179-06	Basement Plan – HVAC
HP – 179-07	Ground Floor Plan – HVAC Piping
HP – 179-08	Second Floor Plan – HVAC Piping
HP – 179-09	Ground Floor Plan – HVAC Ductwork
HP – 179-10	Second Floor Plan – HVAC Ductwork
HP – 179-11	Roof Plan – HVAC
HP – 179-12	Schedules – HVAC
HP – 179-13	HVAC Controls
HP – 179-14	HVAC Controls
HP – 179-15	Drawing Deleted
HP – 179-16	Ground Floor Plan – Architectural Ceiling
HP – 179-17	Second Floor Plan – Architectural Ceiling
HP – 179-18	Ground Floor Plan – Fire Alarm
HP – 179-19	Second Floor Plan – Fire Alarm
HP – 179-20	Site Plan – Fire Alarm
HP – 179-21	Symbols & Abbreviations – Electrical
HP – 179-22	Ground Floor Plan - Lighting
HP – 179-23	Second Floor Plan- Lighting
HP – 179-24	Basement Floor Plan – Electrical
HP – 179-25	Ground Floor Plan – Electrical
HP – 179-26	Second Floor Plan – Electrical

HP – 179-27	Roof Plan – Electrical
HP – 179-28	Schematics – Electrical
HP – 179-29	Schedules – Electrical

Above drawings are general in nature and are intended to indicate the relative locations of the equipment specified in the space provided. It shall be the responsibility of the successful bidder to ascertain the suitability of the specific equipment to be furnished in regard to the space allotted.

- JR-5 **PRE-BID MEETING** A **MANDATORY** Pre-Bid Meeting for all prospective bidders will be held on **Tuesday, October 9, 2012 at 10:00 A.M.** CDT at the Howard Avenue Water Purification Plant, 3929 South 6th Street, Milwaukee WI, 53221. The City of Milwaukee will **ONLY** receive bids from prospective bidders who are in attendance at the **MANDATORY** Pre-Bid Meeting. The official envelope for submitting a bid will be available at the **MANDATORY** Pre-Bid Meeting. Bidder participation is urged to become familiar with all aspects of the project and bidding requirements. All attendees shall contact both karl.s.rohrbach@milwaukee.gov and mark.a.gremmer@milwaukee.gov a minimum of 24 hours prior to the Pre-Bid Meeting to be placed on the visitors list. Bidders that are not on the visitors list will not be granted access to the Howard Avenue Purification Plant.
- JR-6 **SITE VISIT** A site visit will be available at the conclusion of the **MANDATORY** Pre-Bid Meeting.
- JR-7 **PRE-CONSTRUCTION MEETING** After the Notice to Proceed is issued, a date shall be set for the pre-construction meeting to be held at the job site. Construction details of the project will be discussed in the meeting.
- JR-8 **JOB SCHEDULE** Within ten (10) days after Notice to Proceed is issued, the contractor shall submit a construction schedule for approval. The schedule shall be made in sufficient detail to indicate dates of each significant operation. The schedule shall be such that the entire job will be completed within the specified completion time. Microsoft Project 2000 shall be used to create the schedule. Submit an electronic file and hardcopy of the schedule.

The contractor shall place all orders for materials promptly after award of the contract. With submittal of the construction schedule, he/she shall include a schedule of delivery of all major material and equipment required for the job.

The contractor shall immediately notify the City of Milwaukee (City), in writing, of any problems with meeting this schedule. If the construction schedule cannot be met because of materials or equipment deliveries, the contractor shall be required to submit purchase orders and confirmations of delivery, showing the date the order was placed and the promised date of delivery.

JR-9 WORK DAYS AND TIMES Work shall take place between the hours of 7:30 AM and 3:30 PM. Work shall not be allowed on Saturday, Sunday, or City holidays.

JR-10 COMPLETION DATE Final completion of work shall be complete by **Friday, May 31, 2013**.

JR-11 CHARGE FOR INSPECTION The contractor will be charged \$350.00 per day per inspector for each and every day inspection is required on this contract after the date allowed for completion, or after such extension of time as may have been granted. This charge is further defined in Section 2.5.11 of the Department of Public Works (DPW) General Specifications.

JR-12 PROGRESS PAYMENTS Within ten (10) days after the Notice to Proceed is issued, the contractor shall submit to the City for approval a schedule showing the breakdown of the contract with quantities and prices as a basis for checking and computing progress estimates. The values shown in the approved breakdown shall be used for pay purposes only and shall not be used as a basis for additions to or deductions from contract work.

When the contractor proceeds properly and with diligence to perform and complete the work on this contract, the Commissioner of Public Works (Commissioner) may, from time to time as the work progresses, grant to the contractor an estimate of the amount already earned. In making such progress estimates, there shall be retained 5% of each progress estimate until final completion and acceptance of the work; except that after 50% of the work has been completed and the Commissioner finds that satisfactory progress is being made and all conditions complied with, he may authorize any of the remaining progress payments to be paid in full to the contractor. Progress payments are further defined in Section 2.9.14 of the DPW General Specifications.

In accordance with Charter Ordinance 7.26 as amended 6-1-72, payment for materials delivered to the work or storage site may be authorized by the Commissioner providing the following terms and conditions are met:

- A. The work is progressing properly and such materials as specified are properly stored and suitable for permanent incorporation in the work.
- B. Materials designated for pay in the next progress estimate after delivery shall be limited to fabricated or manufactured components which are assembled in final form ready for placement in the work.
- C. The following forms shall be submitted with requests for payment:
 - 1. Progress Estimate and Request for Payment for Fabricated Materials or Components Properly Stored.
 - 2. Certification of the contractor or his duly authorized representative.

Field Engineer shall verify that material is as specified and properly stored.

- D. The contractor shall be responsible for the safeguarding of any such materials against loss or damage whatsoever, and in the case of any loss or damage, the contractor shall replace such lost or damaged materials at no cost to the City. The Commissioner shall reserve the right to deduct from ensuing progress estimates the value of any lost or damaged materials until such loss or damage is restored by the contractor.
- E. The Commissioner may limit processing progress estimates to those cases where the amount earned in any pay period for work and materials is \$5,000 or more.
- F. Any materials for which payment has been made shall not be removed from the work or storage site without the specific written approval of the Commissioner.

JR-13 FORMAL CORRESPONDENCE Formal correspondence shall be addressed to: Ms. Carrie M. Lewis, Superintendent of Milwaukee Water Works, Zeidler Municipal Building, 841 North Broadway, Suite 409, Milwaukee, WI 53202. Formal correspondence shall include:

1. Request for Change Order.
2. Request for extension of Completion Date.
3. Disputes concerning Payment or Field Issues.
4. Payment Requests.
5. Submittals.

END OF SECTION

SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Contract description
 2. Work by City
 3. Contractor use of site and premises
 4. Work sequence
 5. Owner occupancy
 6. Specifications and standards
 7. Shop Drawings
 8. Warranty and guarantee

1.02 CONTRACT DESCRIPTION

- A. This contract includes the furnishing of all equipment, labor, supervision, materials and appurtenances for and in connection with the demolition and replacement of the HVAC, lighting and ceiling in the Administration Building as shown on the contract drawings and further specified herein.
- B. The Work to be performed shall include but not be limited to the following:
1. Demolition of ceiling, ductwork, light fixtures and HVAC equipment.
 2. Provide chilled water system including, chiller, duplex pumps, buffer tank, piping, controls and associated accessories.
 3. Provide perimeter steam heating system including, convectors, fin-tubes, unit heaters, piping, controls and associated accessories.
 4. Provide air-conditioning and heating system, including air-handlers, coils, louvers, VAV boxes, diffusers, grilles, ductwork, louvers, piping, controls and associated accessories. Provide associated power panels.

5. Provide relief fans, hoods, ductwork, controls and associated accessories.
6. Provide roof mounted powered ventilators. Clean existing ductwork.
7. Provide wall mounted air-conditioning units with roof mounted condensing unit in Library.
8. Provide suspended acoustic ceiling system including metal suspension system and acoustical panels.
9. Provide smoke detection system within HVAC ductwork.
10. Paint mechanical room.
11. If necessary, provide temporary heat to spaces in the Administration Building. All spaces in the building shall be maintained at a minimum 68° F during occupied hours.
12. Provide temporary lighting.
13. Provide conduit, wiring and junction boxes for new light fixtures. Provided light fixtures and associated controls and lamps.

1.03 WORK BY CITY

- A. The City will provide labor and materials for supporting existing wiring and cables that are routed inside the space between the existing plaster ceiling and the building's concrete structure. Wiring and cables are routed in this space for electrical power, SCADA and security.

1.04 CONTRACTOR USE OF SITE AND PREMISES

- A. Limit use of site and premises to allow:
 1. Owner Occupancy of Basement, Ground Floor and Second Floor.
 2. Delivery of Chemicals. Two or three times during the workweek, a semi-truck with a tanker trailer will need access to the Administration Building's courtyard or east side for unloading chemicals.
 3. Contractor shall coordinate activities with City forces and City Contractors who will be supporting existing wiring and cables that are routed inside the space between the existing plaster ceiling and the building's concrete structure.
 4. Contractor will be allowed to place one (1) roll-off dumpster in the Administration Building's courtyard. The dumpster shall be next to the loading dock.

5. The contractor shall ensure that construction activities do not damage vehicles in the Administration Building's parking lot. The contractor shall be responsible for protecting vehicles in the parking lot from construction debris and dust.

1.05 OWNER OCCUPANCY

- A. The City will occupy the premises during the entire period of construction.
- B. Cooperate with City to minimize conflict, and to facilitate City's operations.
- C. Schedule the Work to accommodate City occupancy.

1.06 SPECIFICATIONS AND STANDARDS

- A. Materials, general design, design loads, allowable stresses, joint design, shop fabrication and field construction shall conform to the requirements of the following latest standard specifications of any technical society, organization, or association, or to codes of local or state authorities:
 1. NEC, National Electric Code.
 2. AWWA, American Water Works Association.
 3. IEEE, Institute of Electrical and Electronic Engineers.
 4. ANSI, American National Standards Institute.
 5. SSPC, The Society for Protective Coatings.
 6. ASTM, American Society for Testing and Material.
 7. The Wisconsin Administrative Code.
 8. OSHA, U.S. Department of Labor Occupational Safety and Health Act.
 9. EPA, United States Environmental Protection Agency.
- B. The contractor shall be familiar with the requirements of the above agencies. Any conflict in the contract drawings, these specifications, the contractor's design or construction methods shall result in this contractor performing in a manner which conforms to the applicable requirements. Agencies and/or associations not specified above are referenced in individual specification sections as required.

1.07 SHOP DRAWINGS

- A. Within three weeks after Notice to Proceed is issued, the Contractor shall submit to the City for approval a minimum three (3) copies of all shop, fabrication,

assembly, and other drawings required by the specifications; all drawings of equipment and devices offered by the Contractor; all drawings showing essential details of any change in design or construction proposed by the Contractor; and all necessary wiring, piping and appurtenance layouts. Drawings of equipment and devices shall show sufficient detail to adequately depict the construction and operation of each item.

- B. Each shop drawing shall bear City of Milwaukee, the name and location of the structure, job number, the name of Contractor, the date of the drawing, the date of each correction or revision and the specification numbers and plan sheet numbers applicable thereto.
- C. Three (3) revised copies of each drawing shall be submitted each time a drawing is returned to the Contractor for revision. The final approval of a drawing shall be included in the Operation and Maintenance manuals,
- D. After approval by the City, all such drawings shall become a part of the contract documents and the work or equipment shown thereby shall be furnished and installed as shown unless otherwise required by the City. No work shall be performed or equipment manufactured until drawings have been approved. The approval of drawings submitted by the Contractor will be for, and will cover only general conformity to the plans and specifications and will not constitute a blanket approval of all dimensions, quantities, or details of the material or equipment shown by such drawings, nor shall such approval relieve the Contractor of responsibility for errors contained therein
- E. At the completion of work and prior to final payment, the Contractor shall provide the City with three (3) sets of "as-built" drawings for the completed job showing all new and modified appurtenances. All conduit or similar items shall be located by dimensions and elevations. The Contractor will be responsible for the accuracy of these drawings.

1.08 WARRANTY AND GUARANTEE

- A. The Contractor shall furnish a written two (2) year warranty from the date of official acceptance against defective materials or workmanship before the final payment is made.
- B. During the period of two (2) years from and after the date of the final acceptance by the City of the work embraced by this contract, the Contractor shall make all needed repairs arising out of defective workmanship or materials, or both, which in the judgment of the Commissioner of Public Works, shall become necessary during such period. The City will perform an inspection during the spring of the final year of the warranty. The Contractor is not required to attend this inspection. A written report summarizing the inspection and detailing any needed

repairs will be provided to the Contractor. The Contractor shall make all repairs within 6 months of receiving the report.

- C. Whenever defective equipment or materials are replaced, the warranty period for the replacement equipment or materials shall be the remaining warranty period for the original, replaced equipment or materials.
- D. If within ten days after mailing of a notice in writing to the Contractor, or his agent, the said Contractor shall neglect to make, or undertake with due diligence to make, the aforesaid repairs, the City is hereby authorized to make such repair at the Contractor's expense; providing, however, that in case of an emergency where, in the judgment of the Commissioner, delay would cause serious loss or damage, repairs may be made without notice being sent to the Contractor, and the Contractor shall pay the cost thereof.
- E. The Contractor shall also furnish written guarantees as required by each Section. Length of time and requirements of guarantees are specified in each Section. Each guarantee shall commence on the date of official acceptance. Final payment will not be paid until the City receives all guarantees.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01039**COORDINATION AND MEETINGS****PART 1 GENERAL****1.01 SECTION INCLUDES:**

- A. Coordination
- B. Alterations
- C. Cutting and Patching
- D. Pre-construction Meeting
- E. Pre-installation Meetings
- F. Progress Meetings

1.02 COORDINATION

- A. Coordinate scheduling, submittals, and work on the various sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements.
- B. Verify that the City of Milwaukee (City) requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate space requirements and installation of appurtenance, mechanical and electrical work. Follow routing shown for pipes, and conduit, as closely as practicable; place runs parallel with line of structure. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. Coordinate completion and clean up of work of separate sections in preparation for substantial completion.
- E. Coordinate correction of defective work and work not in accordance with contract documents, to minimize disruption of the City's activities.

1.03 ALTERATIONS

- A. Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.
- C. Remove, cut and patch work in a manner to minimize damage and to provide a means of restoring products and finishes to original condition.
- D. Refinish visible existing surfaces to original condition.
- E. Where new work abuts or align with existing, perform a smooth and even transition. Patched work to match existing adjacent work in texture and appearance.
- F. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to the City.
- G. Patch or replace portions of existing surfaces that are damaged, lifted or discolored, or showing other imperfections.
- H. Finish surfaces as specified in individual product Sections.

1.04 CUTTING AND PATCHING

- A. Employ skilled and experienced installer to perform cutting and patching.
- B. Submit written request in advance of cutting or altering elements which affects:
 - 1. Structural integrity of element.
 - 2. Integrity of weather-exposed or moisture resistant element.
 - 3. Efficiency, maintenance or safety of element.
 - 4. Visual qualities of sight-exposed elements.
 - 5. Work of City or separate contractor.
- C. Execute cutting, fitting and patching to complete work, and to:
 - 1. Fit the several parts together, to integrate with other work.
 - 2. Uncover work to install or correct ill-timed work.
 - 3. Remove and replace defective and non-conforming work.

4. Remove samples of installed work for testing.
5. Provide openings in elements of work for penetrations of mechanical and electrical work.
6. Execute work by methods which will avoid damage to other work, and provide proper surfaces to receive patching and finishing.
7. Cut rigid materials using masonry saw or core drill.
8. Restore work with new products in accordance with requirements of contract documents.
9. Fit work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
10. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
11. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.
12. Identify and hazardous substance or condition exposed during the work to the City.

1.05 PRECONSTRUCTION MEETING

- A. The City will schedule a pre-construction conference after Notice of Award.
- B. Attendance Required: City and Contractor.
- C. Agenda
 1. Submission of executed bonds and insurance certificates (unless previously submitted to DPW).
 2. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
 3. Designation of personnel representing the parties in contract.
 4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, change orders and contract closeout procedures.
 5. Scheduling and reports.
 6. Use of premises by City and contractor.

7. Construction facilities and controls provided by City.
8. Temporary utilities and controls provided by City, if any.
9. Security and housekeeping procedures.
10. Procedures for testing.
11. Procedures for start-up of equipment.
12. Requirements for maintaining record documents.
13. Inspection and acceptance of equipment put into service during construction period.
14. Conflicts.
15. A review of contract documents shall be made and deviations or differences shall be resolved.
16. Establish which areas on-site will be available for use as storage areas and working area.

1.06 PRE-INSTALLATION MEETING

- A. When determined by the City, convene a pre-installation meeting at work site prior to commencing work.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify all parties four (4) days in advance of meeting date.
- D. Prepare agenda, preside at meetings, record minutes, and distribute copies within three (3) days after the meeting to participants, with one (1) copy to the City.
- E. Review conditions of installation, preparation and installation procedures, and coordination with related work.

1.07 PROGRESS MEETING

- A. The City will schedule and administer meetings throughout progress of the work as required.
- B. The City will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes and distribute copies within three (3) days to the City, participants, and those affected by decisions made.

- C. Attendance Required: Contractor's general superintendent, major subcontractors and suppliers, City, as appropriate to agenda topics for each meeting.
- D. Agenda
 - 1. Review minutes of previous meeting.
 - 2. Review of work.
 - 3. Field observations, problems and decisions.
 - 4. Field observations of problems that impede planned progress.
 - 5. Review submittal schedule and status of submittals.
 - 6. Review of off-site fabrication and delivery schedules.
 - 7. Maintenance of progress schedule.
 - 8. Corrective measures to regain projected schedules.
 - 9. Planned progress during succeeding work period.
 - 10. Coordination of projected progress.
 - 11. Maintenance of quality and work standards of proposed changes on progress schedule and coordination.
 - 12. Other business relating to work.

END OF SECTION

SECTION 01500
JOB SITE SECURITY, UTILITES AND FACILITIES

PART 1 SCOPE

1.01 INDEX

- A. Scope
- B. Security and Safety
- C. City of Milwaukee Permits
- D. Occupancy during construction
- E. Electric Power
- F. Water
- G. Toilet Facilities
- H. Deliveries

1.02 GENERAL CONDITIONS

- A. All operations shall be carried on with a minimum of damage and disturbance. All damages shall be repaired to the original condition to the satisfaction of the Engineering Representative.
- B. All removals become the property of the Contractor and shall be disposed of off the site unless otherwise specified.
- C. Disposal of all waste and debris generated during the removal and installation operations shall be conducted in accordance with the latest edition of all local, state and federal rules and regulations governing the waste product. Copies of any required certificates, forms, manifests, etc. required for proper disposal shall be submitted to the City in accordance with Section 01010, Submittals.

1.03 TEMPORARY VENTILATION

- A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

1.04 TEMPORARY HEAT

- A. Contractor shall provide temporary heat if existing or new heating system is not capable of keeping spaces in the Administration Building at a minimum temperature of 68° F during occupied periods.

1.05 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Protect non-owned vehicular traffic stored materials, site and structures from damage.

1.06 PROGRESS CLEANING

- A. Waste materials, debris, and rubbish shall be removed daily after work. Maintain site in a clean and orderly condition.
- B. Clean and repair damage caused by removals or installations.
- C. Restore existing facilities used during construction to original condition.

PART 2 SECURITY AND SAFETY

2.01 GENERAL

- A. The Milwaukee Water Works consists of a number of facilities to treat and deliver drinking water to the City and surrounding suburban communities. To insure the safety and security of drinking water, the Milwaukee Water Works has instituted protocols for visitors and contractors to control entry to these facilities. It is essential that contractors strictly comply with the security policy outlined in the specification section.
- B. For this project, the Contractor shall continuously coordinate building and site security measures, including accessing the site, with the designated Water Engineering representative or the Water Security Manager, Telephone # (414) 286-3465.

2.02 SCOPE

- A. Any and all City agencies and contractors engaged for work at Milwaukee Water Works facilities shall be required to attend the "Pre-Construction Meeting" before any contracted work can be initiated. At this meeting, the contractor and sub-contractors shall have a detailed briefing with discussions regarding the following items:
1. Milwaukee Water Works site security policies and procedures
 2. Contractor & Sub-Contractor Obligations
 3. Notifying City prior to commencing work that may impact Milwaukee Water Works operations.

2.03 POLICIES

- A. At the, "Pre-Construction Meeting", Milwaukee Water Works staff shall provide the Prime Contractor with site polices to be reviewed by the Prime and Sub Contractors. These documents may include:
1. Lock-out / Tag-out Policy
 2. Confined Space Entry Procedures
 3. Evacuation Procedure for Propane, Lox, & Ammonia Releases
 4. Personal Protective Equipment Guidelines
 5. No Smoking Policy
 6. Prohibited Materials
- B. Additionally, the Contractor will be provided:
1. Contact Phone Numbers for MWW Staff.
 2. On-Site Parking Location and designated construction entrance.
 3. Site security policy and procedures.
- C. The Prime Contractor shall be required to review these documents and is responsible for conveying the contents of these submittals to their employees, sub-contractors, and any other parties working directly or indirectly for them. These policies apply equally to all contractors. Failure to comply with established policies and procedures may result in access privileges being withdrawn.
- D. MWW Staff shall provide a "walk-through" session with the contractor to review area layout and site plans as part of this orientation process and to establish the specific work areas necessary for the contractors to perform their scope of work.

Topics covered in this session include: site overview with hazards, material safety data sheets, fire extinguisher placement, and the storm water protection policy.

2.04 CONTRACTOR RESPONSIBILITIES

- A. Contractors shall provide the following documents no less than 7 days prior to the start of contracted work. Documents shall be sent to the Water Security Manager, (414) 286-3465:
1. Scope of work to be performed;
 2. Name of primary contractor's onsite representative;
 3. Names of all companies sub-contracted to do work on the project;
 4. Completed "Contract Firm Registration Form" (see attachment 'A') for prime contract firm and every sub-contract firm;
 5. A "Contractor Employee Registration Form" completed for the contractors and every employee who needs to be granted site access (see attachment 'B');
 6. List of items to be stored on-site;
 7. Material Safety Data Sheets for all chemicals to be used/stored on-site;
- B. It is the responsibility of the Primary Contractor to facilitate gathering the "Contractor Employee Registration Form" for all sub-contractors working on the project. A sub-contractor is defined as an individual or firm hired by the primary contractor to perform a specific task as part of the overall project. This would not include an organization making deliveries of supplies or equipment to the job site; procedures for these firms are covered under Part 8, "DELIVERIES".
- C. In the event it is necessary for the Prime Contractor to add additional employees to the list of approved personnel, a minimum of 72 hours, or 3 business days, must be allowed for processing of the request. Site access will be denied to the additional personnel until processing is complete.
- D. Contract firms are obligated to notify the Water Security Manager, (414) 286-3465 in a timely manner of any site-authorized staff that leaves the employ of the contractor.
- E. Only the Primary Contractor should be contacting the Water Security Manager with issues or access requests. If a request for site access does not come from the Primary Contractor, the request will not be processed.
- F. During the time period that the Contractor is on-site, they must agree to:
1. Notify the Plant Manager immediately of any significant chemical spills or leaks;

2. Maintain Normal Non-Toxic Breathable Air Quality, through Adequate Ventilation, at their work site;
3. Perform no equipment isolations or tie-ins without the signed approval of Milwaukee Water Works;
4. Restrict movement to the specific work areas within the Site to perform Contractors Scope of Work;

2.05 CONTRACTOR NOTIFICATION OF CITY

- A. Contractors must notify Engineering / Site Management Staff of any welding, torching, or potentially hazardous or operational impact request, prior to commencing such operations.
- B. Failure to comply with the terms of the provisions that provide for MWW Employee Safety shall be cause for the contractor to discontinue activities at the Site.

2.06 CONTRACTOR IDENTIFICATION AND DAILY REGISTRATION

- A. Every day, all contractors shall be required to show a valid ID card, to sign-in at the start of work, and sign out at the end of work. A MWW employee or designated security representative shall be on site to ensure compliance. Any identification tags or lanyards issued by MWW are to be worn while on site and returned to site management upon completion of contracted work.

2.07 CONTRACTOR GATE ACCESS & PARKING

- A. Contractors must comply with the terms of entry for the site and park only in the areas designated for parking by the MWW site representative.
- B. Parking privileges may be rescinded at any time as Site Operational Requirements dictate.

PART 3 CITY OF MILWAUKEE PERMITS

- 3.01 See Chapter 2.3.0 – Necessary Notices and Permits of the Department of Public Works General Specifications for further information and requirements.

PART 4 OCCUPANCY DURING CONSTRUCTION

- 4.01 During the Contractor's performance of the work, the City will continue to occupy the existing building. The Contractor shall take precautions to prevent the spread of dust and debris, particularly where such material may sift into the building. The Contractor shall provide labor and materials to construct, maintain and remove necessary temporary enclosures to prevent dust or debris in the construction area(s) from entering the remainder of the building.

PART 5 ELECTRICAL POWER

- 5.01 Limited electrical power for construction purposes is available at the site and will be made available to the Contractor. The Contractor's equipment shall not exceed the capabilities of these receptacles. The Contractor shall provide additional electrical power if their equipment exceeds the capabilities of the receptacles.
- 5.02 Contractor shall provide and maintain all necessary power cords, electrical lighting, heat and ventilation, and shall make all necessary connections in accordance with OSHA regulations.

PART 6 WATER

- 6.01 Water for construction purposes is available at the site and will be made available to the Contractor.
- 6.02 Contractor shall provide all hoses, back flow preventer, valves and connections for water from source designated by the City.

PART 7 TOILET FACILITIES

- 7.01 Sanitary facilities are available at the site and will be made available to the Contractor.

PART 8 DELIVERIES

- 8.01 Contractor shall coordinate the delivery of all equipment, material, Dumpsters, portable toilets and other required items required for the contract work with the MWW staff. A minimum of 24 hours prior notice in advance of the desired delivery date shall be transmitted to the designated Water Engineering Representative. Contractor shall provide the following information in the notification:
- A. Trucking/Delivery Company
 - B. Driver Name
 - C. Truck License Plate Number
- 8.02 The driver of the delivery vehicle is required to display picture identification as a pre-requisite for entry to the MWW facility for the delivery. Failure to comply with the above will result in denial of project site access, requiring the contractor to re-schedule delivery.

END OF SECTION



Safe, Abundant Drinking Water.

HP-179
Attachment "A"

FORM A

CONTRACT FIRM REGISTRATION FORM

CONTRACTOR: _____

PLANT/SITE: _____

CONTRACT/SERVICE ORDER No. _____

WATER ENGINEERING PROJECT No. _____

PRIMARY CONTACT PERSON: _____

OFFICE PHONE NUMBER: _____

CELL PHONE NUMBER: _____

REQUESTED WORK HOURS (00am – 00pm): _____

NUMBER OF EMPLOYEES TO BE WORKING ON-SITE: _____

**Signature certifies receipt of the materials outlined in
Contract Section 01500, Part 2 – Security and Safety, Section C, Policies.**

SIGNATURE: _____
PRIMARY CONTACT PERSON

DATE: _____

***Accompanying this form should be a complete listing of all
equipment to be stored on site for the duration of the project.***



Safe, Abundant Drinking Water.

HP-179
Attachment "B"

FORM B

CONTRACTOR EMPLOYEE REGISTRATION FORM

Contract Firm: _____

Plant/Site/Project: _____

Employee Name (Printed): _____

This certifies that I have received the building site security and safety policies.

EMPLOYEE
SIGNATURE: _____

Required

DATE: _____

ONSITE PARKING

- I will always be driving a Company vehicle.
- I will always be a passenger in a vehicle.
- I will be driving my personal vehicle. If checked here complete and sign the next section.

Contractor Personal Vehicle Liability Waiver

EMPLOYEE VEHICLE

MAKE & MODEL: _____ LICENSE PLATE: _____

I, hereby agree to hold harmless the City of Milwaukee for any and all damage, loss or injury, which may occur as a result of utilizing the contractor onsite parking area.

EMPLOYEE
SIGNATURE: _____

Required

DATE: _____

SECTION 01600**MATERIAL AND EQUIPMENT****PART 1 GENERAL****1.01 SUMMARY**

- A. Section includes:
 - 1. Products.
 - 2. Transportation and handling.
 - 3. Storage and protection.
 - 4. Product options.
 - 5. Substitutions.

1.02 PRODUCTS

- A. Material, machinery, components, equipment, fixtures and system shall be new. Assure standardization and uniformity by using products from one (1) manufacturer.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the contract documents.
- C. Provide interchangeable components of the same manufacture for components being replaced.

1.03 TRANSPORTATION AND HANDLING

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement or damage.

1.04 STORAGE AND PROTECTION

- A. Store and protect products in accordance with manufacturer's instructions.

- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Provide off-site storage and protection when site does not permit on-site storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement or damage.
- I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.05 PRODUCT OPTIONS

- A. Products specified by reference standards or by description only: Any product meeting those standards or description.
- B. Products specified by naming one or more manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products specified by naming one or more manufacturers with a provision for substitutions: Submit a request for substitution for any manufacturer not named in accordance with the following article.

1.06 SUBSTITUTIONS

- A. City will consider requests for Substitutions only within fifteen (15) days after date established in Notice to Proceed, unless otherwise specified in individual specification sections.
- B. Substitutions may be considered when a product becomes unavailable through no fault of the contractor.
- C. Document each request with complete data substantiating compliance of proposed substitution with contract documents.

- D. A request constitutes a representation that the contractor:
1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 2. Will provide the same warranty for the substitution as for the specified product.
 3. Will coordinate installation and make changes to other work that may be required for the work to be complete with no additional cost to City.
 4. Waives claims for additional costs or time extension that may subsequently become apparent.
 5. Will reimburse City for review or redesign services associated with re-approval by authorities.
- E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the contract documents.
- F. Substitution Submittal Procedure:
1. Submit two (2) copies of request for substitution for consideration. Limit each request to one (1) proposed substitution.
 2. Submit shop drawings, product data and certified test results attesting to the proposed Product equivalence. Burden of proof is on proposer.
 3. The City will notify contractor in writing of decision to accept or reject request.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01650
STARTING OF SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Starting systems.
 - 2. Demonstration and instructions.
 - 3. Testing, adjusting and balancing.
- B. Related Sections
 - 1. Section 01700 – Contract Closeout

1.02 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify City seven (7) days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence and for conditions which may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Provide expendables required for initial start-up of equipment unless otherwise specified.
- G. Execute start-up under supervision of applicable contractors' personnel in accordance with manufacturers' instructions.
- H. When specified in individual specification sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

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

1.03 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products to City's personnel on mutually agreeable dates prior to date of initial placement in service and final payment.
- B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six (6) months.
- C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with City personnel in detail to explain all aspects of operation and maintenance.
- D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time and location.
- E. Prepare and insert additional data in operation and maintenance manuals when need for additional data becomes apparent during instruction.
- F. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

1.04 TESTING, ADJUSTING AND BALANCING

- A. Contractor shall employ and pay for services of an independent firm to perform testing, adjusting and balancing.
- B. The independent firm shall perform services specified in Section 15990 – Testing, Adjusting and Balancing.
- C. Reports shall be submitted by the independent firm to the City indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the contract documents.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01700
CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Closeout Procedures.
 - 2. Final Cleaning.
 - 3. Adjusting.
 - 4. Project Record Documents.
 - 5. Operation and Maintenance Data.
 - 6. Spare Parts and Maintenance Products
 - 7. Guarantee.
- B. Related Sections
 - 1. Section 01500 – Job Site Security, Utilities and Facilities: Progress cleaning.
 - 2. Section 01650 – Starting of Systems.

1.02 CLOSEOUT PROCEDURES

- A. Submit written certification that contract documents have been reviewed, work has been inspected, and that work is complete in accordance with contract documents and ready for City's review.
- B. Provide submittals to City that is required by governing or other authorities.
- C. Submit final application for payment identifying total adjusted contract sum, previous payments and sum remaining due.

1.03 FINAL CLEANING

- A. Execute final cleaning prior to final inspection.

- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- D. Replace filters of operating equipment.
- E. Clean site; sweep paved areas, rake clean landscaped surfaces.
- F. Remove waste and surplus materials, rubbish and construction facilities from the site.

1.04 ADJUSTING

- A. Adjust operating appurtenances and equipment to ensure smooth and unhindered operation.

1.05 PROJECT RECORD DOCUMENTS

- A. Maintain on site, one (1) set of the following record documents; record actual revisions to the work:
 - 1. Contract Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders.
 - 5. Reviewed Shop Drawings, Product Data, and Samples.
 - 6. Manufacturer's instructions for assembly, installation and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by City.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Contract Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.

2. Field changes of dimension and detail.
 3. Details not on original drawings.
- F. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
1. Manufacturer's name and product model and number.
 2. Product substitutions or alternates utilized.
 3. Changes made by addenda or change orders.
- G. Submit documents to City in the following manner:
1. Submit prior to final application for payment.
 2. Documents shall be accompanied with a transmittal letter that includes the following:
 - a) Date.
 - b) City's project title and number.
 - c) Contractor's name and address.
 - d) Title and number of each record document.
 - e) Certification that each document as submitted is complete and accurate.
 - f) Contractor's signature or authorized representative.
 3. Delete consultant and City's title block from documents. Delete engineer's seals from documents.
 4. Submit two (2) sets of documents.
 5. Submit one (1) set of reproducible "mylar" contract drawings.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit data bound in 8-1/2 x 11 inch text pages, three D-side ring binders with durable plastic covers. Drawings and diagrams shall be reduced to 8-1/2 x 11 inches or 11 x 17 inches. Where reduction is not practicable, large drawings shall be folded separately and placed in an envelope that is bound into the manuals. Envelope shall bear suitable outside identification.

- B. Prepare binder cover and spine with printed title “OPERATION & MAINTENANCE INSTRUCTION”, title of project, project number and subject matter of binder when multiple binders are required.
- C. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, typed on 24-pound white paper, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, telephone numbers and emails of architect/engineer, contractor, subcontractors and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, telephone numbers and e-mails of subcontractors and suppliers. Identify the following:
 - a) Significant design criteria.
 - b) List of equipment.
 - c) Parts list and assembly drawings for each component.
 - d) Operating instructions for start-up, normal operation, shutdown and emergency conditions.
 - e) Maintenance instructions for equipment and systems.
 - f) Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
 - g) Troubleshooting guide.
 - 3. Part 3: Project documents and certificates, including the following:
 - a) Shop drawings and product data.
 - b) Air and water balance reports.
 - c) Certificates.
 - d) Photocopies of warranties.

- E. Submit one (1) draft copy of volumes fifteen (15) days prior to final inspection. This copy will be reviewed and returned with City comments. Revise content of all document sets as required prior to final submission.
- F. Submit four (4) sets of revised final volumes within ten (10) days after receipt of City's comments.

1.07 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Provide spare parts, maintenance, and extra products in quantities specified in individual specification sections.
- B. Deliver to project site and place in location as directed; obtain receipt prior to final payment.

1.08 WARRANTY AND GUARANTEE

- A. Provide duplicate notarized copies.
- B. Execute and assemble transferable warranty documents from subcontractors, suppliers and manufacturers.
- C. Provide Table of Contents and assemble in binder with durable plastic cover.
- D. Submit prior to final application for payment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02220
DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Demolition

1.02 PRE-DEMOLITION MEETING

- A. Conduct pre-demolition meeting in accordance with Section 01039.
- B. Convene pre-demolition meeting one week prior to commencing work of the Section.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with work in accordance with Section 01710

3.02 PREPARATION

- A. Notify City or appropriate utilities to turn off affected services before starting demolition or alterations.
- B. Provide 48 hour notice prior to starting demolition in a space.

3.03 DEMOLITION

- A. See notes on Contract Drawings.
- B. The ceilings in the hallways, bathrooms, locker rooms and common areas shall be removed first. The drop ceilings in Room 11 and the Assembly Room shall be removed last.
- C. The Contractor shall provide a dust free environment for the autoclave and particle counter.
 - 1. The autoclave is permanently located in the Media and Wash-up Room. Approximate dimensions of the autoclave are 4-feet long x 3-feet wide x 6-feet high.

2. The particle counter is located in the Bacteriological Lab. The particle counter is located on a table top and can be relocated. Approximate dimensions of the particle counter are 2-feet long x 2-feet wide x 2-feet high.
- D. The Contractor shall be responsible for relocating and/or protecting equipment and furniture in the building

3.04 TEMPORARY HEATING

- A. The Contractor shall provide temporary heat if there is a need for heat after the heating system has been demolished. Spaces in the Administration Building shall be maintained at a minimum temperature of 68° F during occupied periods. The Administration Building is occupied between the hours of 6:00 AM to 4:00 PM. Except for Room 11, the temperature in the Administration Building may be setback to 60° F during the hours of 4:00 PM to 6:00 AM. Room 11 shall be maintained at a minimum temperature of 68° F, 24-hours a day.

3.05 DISPOSAL

- A. Equipment and materials within the limits of demolition, unless otherwise specified, shall become property of the Contractor.

END OF SECTION

SECTION 09510
ACOUSTIC CEILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal Suspension System.
 - 2. Acoustical Panels.

1.02 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Product Data:
 - 1. Submit manufacturer's descriptive literature, product specifications and installation instructions for each product.
 - 2. Include data to indicate dimensions, load carrying capacity and standard compliance.
 - 3. One 6-inch square of each acoustical unit material.
 - 4. One, full-size sample of each suspension system member and molding.
- C. Shop Drawings:
 - 1. Submit detail drawings of grid indicating hanger spacing, fastening and splicing details.

1.03 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.04 EXTRA MATERIALS

- A. Furnish under provisions of Section 01700 – Contract Closeout.
- B. Additional acoustical units from the same production run as installed equal to three percent (3%) of ceiling area.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Acceptable to manufacturer with experience on at least five (5) projects of similar nature in past five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of Section 01600 – Material and Equipment.

1. Deliver materials with manufacturer's labels indicating brand name, pattern, size, thickness, and fire rating.
2. Store materials in original protective packaging to prevent soiling, physical damage or wetting.
3. Maintain humidity of 65 to 75 percent in area where acoustical materials are to be installed for 25 hours before, during and 25 hours after installation.
4. Maintain a uniform temperature of 55°F to 70°F prior to, and during installation of materials.

1.07 GUARANTEE

- A. Comply with provisions of Section 01010 – Summary of Work.
- B. Thirty (30) year lifetime system warranty against visible sag, mold and mildew on panels.

PART 2 PRODUCTS

2.01 METAL SUSPENSION SYSTEM

- A. Acceptable Manufacturers
 1. USG Interiors, Inc.
 2. Substitutions: Under provisions of Section 01600.
- B. Offices, Laboratories and Common Areas
 1. Donn DX/DXL 15/16" Tee System; exposed, hot-dipped galvanized grid system with steel cap.
 - a) Main Tee
 - (1) Item #DX/DXL24
 - (2) ASTM Class: Intermediate Duty
 - (3) Length: 12 – feet
 - (4) Height: 1.64 – inches
 - (5) Class: UL Fire Rated
 - (6) Rated Load w/ 4' hanger spacing: 12 lbs/LF
 - b) Cross Tee
 - (1) Item #DX/DXL216
 - (2) Length: 2 – feet
 - (3) Height: 1 – inch
 - (4) Class: UL Fire Rated

- c) Wall Angle
 - (1) Item #M7
 - (2) Length: 12 – feet
 - (3) Width: 7/8 – inch
 - (4) Height: 7/8 - inch
 - d) Color: City to select from standard color selection
- C. Locker Rooms and Bathrooms
- 1. Donn ZXLA 15/16” Tee System; exposed, hot-dipped galvanized grid system with aluminum cap. Polyester paint finish and stainless steel clips.
 - a) Main Tee
 - (1) Item #ZXLA24
 - (2) ASTM Class: Intermediate Duty
 - (3) Length: 12 – feet
 - (4) Height: 1.64 – inches
 - (5) Class: UL Fire Rated
 - (6) Rated Load w/ 4’ hanger spacing: 12 lbs/LF
 - b) Cross Tee
 - (1) Item #ZXLA224
 - (2) Length: 2 – feet
 - (3) Height: 1-1/2 – inch
 - (4) Class: UL Fire Rated
 - c) Wall Angle
 - (1) Item #M7Z
 - (2) Length: 12 – feet
 - (3) Width: 7/8 – inch
 - (4) Height: 7/8 - inch
 - d) Color: Flat White
- D. Attachment Devices
- 1. Size for five (5) times design load indicated in ASTM C635, Table 1, Direct Hung unless otherwise indicated.
- E. Wire for Hangers and Ties
- 1. Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least three (3) times design load, but not less than 12-gauge.

2.02 PANELS

- A. Acceptable Manufacturers
 - 1. USG Interiors, Inc.
 - 2. Substitutions: Under provisions of Section 01600.
- B. Offices, Laboratories and Common Areas
 - 1. Frost ClimaPlus; Item #414
 - a) Edge: SLB
 - b) Panel Size: 2'x2'x3/4"
 - c) Class: A; per ASTM E84
 - d) NRC: 0.70
 - e) CAC: 38
 - f) LR Minimum: 0.83
 - g) Color: City to select from standard color
- C. Locker Rooms and Bathrooms
 - 1. Radar Ceramic ClimaPlus; Item #56644
 - a) Edge: Square
 - b) Panel Size: 2'x2'x5/8"
 - c) Class: A; per ASTM E84
 - d) NRC: 0.50
 - e) CAC: 40
 - f) LR Minimum: 0.82
 - g) Color: White

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with work.
- B. Verify that plaster soffit at windows is structurally sound and adequately supported.
- C. Verify that edge of existing plaster ceilings in shower areas are square and true. Verify that edge of plaster ceiling is adequately supported.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions, State of Wisconsin standards, ASTM C636, standard industry practices and approved shop drawings.

- B. System shall meet or exceed load compliance specifications per ASTM C635 for intermediate duty.
 - C. Hang suspended grid level and in straight alignment directly from structure.
 - D. Hanger Wires.
 - 1. Space maximum 4-feet on center each direction and securely attach to structure above.
 - 2. Install additional hangers at ends of each suspension member and 6-inches from vertical surfaces. Light fixtures shall be supported independent of grid structure.
 - 3. Do not splay wires more than 5-inches in a 4-foot vertical drop.
 - 4. Provide four-way splays at 45 degrees from main runner to support structure for every 144 square feet of ceiling area.
 - 5. Wrap wire minimum three (3) times horizontally, turning ends upward.
 - 6. Where hanger wires cannot be hung vertically from structure above because of ducts, pipes cable trays, or other interferences, provide trapezes of steel channels (minimum 2-inches deep, 16-gauge cold rolled carrying channels) hung on steel rods or 8-gauge wire from concrete structure above. Hang ceiling wires from these trapezes or similar members supporting ducts or pipes. Do not hang directly from ducts or pipes.
 - E. Edge Molding
 - 1. Install at intersection of suspended ceiling and vertical surfaces.
 - 2. Miter corners where moldings intersect or install corner caps.
 - 3. Attach to vertical surface with mechanical fasteners.
 - F. Provide additional channels, hangers, and trapezes as required to support all edges of ceiling around and under mechanical and electrical work.
 - G. Install grid system and acoustical tile units in accordance with material manufacturer's recommendations so as to achieve a one-hour, fire resistive rating.
 - H. Acoustical units shall be installed with pattern running in one direction upon completion of suspended grid system and other concealed work.
- 3.03 CLEANING
- A. Clean as recommended by manufacturer. Do not use materials or methods, which may damage finish or surrounding construction.

END OF SECTION

SECTION 15060
PIPING AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Valves & Accessories.
 - 3. Insulation.
- B. Related Sections
 - 1. Section 15950 – Controls.

1.02 REFERENCES

- A. The following documents refer to the latest edition.
- B. ASTM A53/A53M Standard Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- C. ASTM A234/A234M Standard Specifications for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- D. ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- E. ASTM A563 Standard Specification for Carbons and Allow Steel Nuts.
- F. ASME/ANSI B16.9 Factory-Made Wrought Steel Buttwelding Fittings.
- G. ANSI B18.2.1 Square and Hex Bolts and Screws.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Product Data:
 - 1. Submit manufacturer's descriptive literature and product specifications for each product.
- C. Shop Drawings:
 - 1. Indicate typical layout including dimensions.
 - 2. Submit drawings showing field measured dimensions.
- D. Control Valve Coordination

1. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.

1.04 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.
- B. Record information requested in Section 01700 – Contract Closeout.

1.05 QUALITY ASSURANCE

- A. Piping shall be installed in accordance with the recognized best practices of the trade.
- B. Assure that all pipe welding complies with the provisions of the latest revision of the ASME Boiler and Pressure Vessel Code, and the ANSI Code for Pressure Piping B31.1, or such state or local requirements as may supplement codes mentioned above. Repair or replace any work not in accordance with these specifications.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of Section 01600 – Material and Equipment.

1.07 GUARANTEE

- A. Comply with provisions of Section 01010 – Summary of Work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Piping and fittings
 1. Pipe: Black carbon steel, ASTM A53 or A120, Schedule 40 black. Manufacturer shall conform to ASTM A-733.
 2. Fittings: ASME B16.3, malleable iron, or ASTM A234, forged steel welding type, long radius elbows unless shown otherwise.
- B. Isolation Valves
 1. 2-inch and smaller: gate valve, Crane, Model No. 428, 125-pound, bronze body, rising stem, solid wedge gate.
 2. Larger than 2-inch: gate valve, Crane, Model No. 460 if screwed or No. 461 if flanged, 125-pound, iron body, non-rising stem, wedge gate.
- C. Blowdown and Test Valves
 1. Ball valve, Crane, 125-pound
- D. Control Valve and Operator – Steam Radiation
 1. Manufacturer & product; Belimo, B2.
 2. Two-way.

3. Brass body, stainless steel ball and stem.
 4. 120 V, single phase, 60 cycle.
 5. Size of steam valve shall be determined by controls contractor.
- E. Check Valves
1. 2-inch and smaller: Crane, Model No. 37, swing check type, 125-pound, bronze.
 2. Larger than 2-inch: Crane, Model No. 372 if screwed or No. 373 if flanged, swing check type, 125-pound, iron body.
- F. Strainers: Y-type; manufactured by Bestobell; cast iron body; class 125.
- G. Pressure/Vacuum Gauges: manufactured by Trerice; 690 series; 3-1/2" dial; stainless steel case; select appropriate scale.
- H. Thermometers: manufactured by Trerice; Adjustable Angle series; Industrial Thermometers with 12" scales (0-100°F).
- I. Pipe Supports
1. Manufactured by Grinnell, Fee & Mason or Elcen.
 - a) Adjustable hangers, special pipe supports, spring hangers, saddles, anchors, clamps, rods, miscellaneous iron supports and appurtenances required to hang or support the piping systems.
 2. Hangers and hardware shall be zinc plated or galvanized.
- J. Insulation
1. Molded glass fiber (4¼ lb. density) or molded phenolic (3 lb. density) with a K factor of 0.24 at 75°F and factory applied white fire retardant vapor barrier jacket with self-sealing lap. Apply 4-inch vapor barrier strips at all punctures with vapor-proof adhesive. Chilled water supply piping, chilled water return piping, and steam piping to the AHU coils shall have a PVC jacket (30 mil thick).
 2. 1-1/4" and smaller piping shall have 1-inch thick insulation.
 3. 1-1/2-inch and larger piping shall have 2-inch thick insulation.
- K. Bolts: Plated; Grade 5.
- L. Pipe Identification and Color Coding
1. Manufacturers and Products
 - a) Seton Identification Products, Setmark series.
 2. Pipe identification labels shall be provided for the following services.
 - a) Chilled water supply and return.
 - b) Condenser water supply and return.

- c) Steam supply and return.
 - d) Steam condensate.
- 3. Labels shall be snap-around type; label shall be properly sized for the finished outside diameter of the pipe. Each label shall contain an arrow indicating the direction of flow. Label length, background, color, letter size, and letter color shall conform to ANSI A13.1 and OSHA standards.
- M. Substitutions: Under provisions of Section 01600

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with work in accordance with Section 01710.
- B. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.
- C. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves and other openings.

3.02 PREPARATION

- A. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside. Clean and flush all piping before installation.
- B. Provide sufficient planning and foresight in avoidance of obstacles and interferences met in the field.

3.03 INSTALLATION

- A. General
 - 1. Install in accordance with manufacturer's written instructions.
- B. Piping
 - 1. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection.
 - 2. Piping shall be installed to allow for free expansion and contraction, including tight angle loops, cold springing or other satisfactory method without stressing pipe, joints or connected equipment.
 - 3. Piping runs shall be parallel to building or column lines and perpendicular to floor, unless shown otherwise. Lines and risers to be perfectly straight, plumb, true, properly graded and free from depression or pockets.
 - 4. Piping 2-inches and above shall be welded with 2 passes of 6010 and 1 pass of 7018. Welded joints shall be chipped, buffed and painted.

5. Branch connections sized under one-half the main pipe diameter may be made with intersection welds with no projection allowed of the small pipe into the larger pipe.
6. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
7. Route piping in orderly manner and maintain gradient.
8. Install piping to conserve building space and not interfere with use of space.
9. Group piping whenever practical at common elevations.
10. Provide clearance for installation of insulation and access to valves and fittings.
11. Establish invert elevations, slopes for drainage to 1/8 inch per foot. Maintain gradients.
12. Open ends of all piping to be kept closed during construction.
13. Pipe ends shall be reamed to full size and threads shall be clean cut and tapering. Joints in screwed piping shall be made up with an approved thread compound applied to male threads only to avoid leaving compound inside the pipe.
14. Provide air chambers and manual air vents at all high points of the chilled water and steam systems.
15. Provide unions, flanges or grooved couplings in all connections to all equipment, so that equipment can be removed by breaking connections. Unions shall be provided where screwed valves, control equipment, etc., are installed in continuous runs of piping. Unions shall be provided in all screwed types of piping where required for disassembly or for convenience in making repairs.
16. Where flanged connections are installed at pumps, piping shall be assembled and supported with flange bolts loose. Observe the flange alignment before tightening the flange bolts.
17. Openings around pipes penetrating required fire resistive rated floor, wall and roof assemblies shall be filled solidly with material of fire resistive rating equal to the required rating of assembly penetrated, similar to 3M Firebarrier.
18. Securely fasten in place to floors, walls and ceilings. Pipes passing through outside walls and roofs shall be properly flashed and counter flashed to provide a weather-tight seal.
19. For grooved piping system, all couplings, fittings, valves and pipe shall be assembled in accordance with the latest published instructions from the grooved pipe coupling manufacturer.

C. Valves

1. Provide access where valves and fittings are not exposed.
2. Install valves with stems upright or horizontal, not inverted.
3. Provide ¾" Crane #58 drain valves with composition discs and hose threads at all low points in the chilled water system.

D. Piping Supports

1. Piping shall be rigidly supported and anchored so that there is not movement or visible sagging between supports.
2. Provide fender washers and jam nuts at all masonry penetrations.
3. Expansion anchors shall be used to fasten supports to existing concrete and masonry.
4. Piping shall be supported with hangers suitable for the size of piping and located at intervals so as to prevent or damp out excessive vibration.
5. Piping shall be anchored to prevent undue strains on connected equipment and shall not be supported by other piping.
6. Supports, hangers, and anchors shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. All parts of the supporting equipment shall be designed and installed so they will not be disengaged by movement of the supported piping.
7. The maximum spacing for pipe supports shall be:
 - a) ½ inch and smaller: 6 feet
 - b) ¾ or 1-inch: 8 feet
 - c) 1-1/4 or larger (horizontal): 10 feet
 - d) 1-1/4 or larger (vertical): every floor level
8. Piping shall be supported approximately 1-1/2 inches out from the face of walls and as least 3-inches below ceilings.

E. Insulation

1. Insulate all fittings, pump bodies, flanges and valves with mitered segments of insulation and cover with PVC fitting covers. Pump bodies may alternately be covered with elastomeric insulation.
2. Seal ends of pipe insulation with vapor barrier adhesive at all flanges, valves and fittings and at intervals of not more than 20-feet on continuous runs of pipe.
3. Provide pipe shields and inserts at each hanger.
4. The piping insulation should have provisions so it can be removed for cleaning evaporator tubes.

5. Provide insulation on steam piping, chilled water supply piping and chilled water return piping.

F. Control Valve Installation

1. All control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position.
2. Valves shall be installed in accordance with the manufacturer's recommendations.
3. Control valves shall be installed so that they are accessible and serviceable, and such that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
4. Isolation valves shall be installed such that control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screwed type control valves.
5. Provide tags for all control valves indicating service and number. Tags shall be brass, 1-1/2" in diameter, with 1/4" high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

G. Accessories

1. Drains and vents shall be installed at each connection to the chiller. The nipple between the casting on the chiller and the 3/4 ball valve with male hose connection (with hose cap and washer) shall be 304 stainless steel or better.
2. Provide thermometers, temperature sensor wells and sockets. Install on evaporator and condenser water supply and return piping. Install on steam coils supply and return piping.
3. Apply anti-seize compound to bolts and nuts.
4. Pipes passing through floors, walls and ceilings shall have chrome plated brass escutcheons of approved design and finish having outside diameter to cover sleeved openings and inside diameter to fit pipe.

H. Pipe Identification and Color Coding

1. Pipe identification labels shall be provided at all points where:
 - a) Piping leaves or enters a wall, conduit, partition, bulkhead, floor, or ceiling.
 - b) Piping route changes directions.
 - c) At connections to equipment or instruments.
 - d) Adjacent to valves and branch fittings.
 - e) At intervals along the piping not exceeding 20-feet on center, with at least one label applied to each exposed run of pipe.

2. Pipe identification labels shall be applied after the installation is complete.
3. Wherever pipes run parallel to other pipe or electrical conduits, the printed legend and other markings shall be applied in the same relative locations so as to be in either vertical or horizontal linearity, whichever the case may be.
4. Where pipe labels must be placed some distance above or below the normal line of an operator's vision, the lettering shall be placed below or above, respectively, the horizontal centerline of the pipe.

3.04 TESTING

- A. All piping, valves, and accessories installed under this contract shall be tested for tightness and leakage for a one-hour period at 150% of normal operating pressure. The contractor shall provide all necessary equipment and shall perform all work required in connection with these tests. Piping will be tested by observation at normal operating pressures. The section tested shall be slowly filled with water, care being taken to expel all air from the pipes. If necessary, the pipes shall be tapped at high points to vent the air. All joints which are found to leak shall be made tight by approved methods or replaced by the contractor at no additional cost to the City.

3.05 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods, which may damage finish or surrounding construction.

END OF SECTION

SECTION 15620
RECIPROCATING/SCROLL WATER CHILLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Chiller package.
2. Charge of refrigerant and oil.
3. Controls and control connections.
4. Chilled water connections.
5. Condenser water connections.
6. Refrigerant connections.
7. Auxiliary water connections.
8. Starters.
9. Electrical Power connections.
10. Circulating Pumps.
11. Buffer Tank.

B. Related Sections

1. Section 15535 - Refrigeration Piping and Specialties.
2. Section 15952 - Controls and instrumentation.
3. Section 16180 - Equipment Wiring Systems.

1.02 REFERENCES

- A. ANSI/ARI 550/590-2003 - Standard for Water Chilling Packages using the Vapor Compression Cycle.
- B. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code.
- C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- D. ANSI/UL 1995 - Central Cooling Air Conditioners.
- E. ANSI/ASHRAE 90.1 - Energy Efficient Design of New Buildings.
- F. ANSI/UL 984 - Safety Standards for Hermetic Motor Compressors.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.

B. Product Data:

1. Submit manufacturer's descriptive literature and product specifications for each product.
2. Scroll Water Chiller data to indicate:
 - a) Performance data including capacity, nominal and operating performance.
 - b) Mechanical Specifications for unit and accessories describing construction, components and options.
 - c) Submit data on electrical requirements and connection points. Include recommended fuse sizes and MCA, operating, maintenance, and start-up instructions.

C. Shop Drawings:

1. Indicate typical layout including dimensions.
2. Submit drawings showing field measured dimensions.
3. Submit detail drawings of special accessory components not included in manufacturer's product data.
4. Scroll Water Chiller data to indicate:
 - a) Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations. Indicate unit operating weights including dimensions.

D. Substitutions:

1. City will only consider substitutions requests for this section during the period of time starting with the project's advertised date and ending two (2) weeks prior to the project's bid opening date.
2. An addendum will be issued for any and all approved substitutions.
3. Requests for substitution shall include the following information:
 - a) Manufacturer's descriptive literature and specifications for the product line.
 - b) Full product submittal, which shall include:
 - c) Product Data
 - d) Performance Data based on design information shown in drawings
 - e) Mechanical Specifications
 - f) Drawings with Dimensions
 - g) Accessories

1.04 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700 – Contract Closeout.
- B. Maintenance Data: Include instructions for lubrication points and maintenance locations.

1.06 EXTRA MATERIALS

- A. Furnish under provisions of Section 01700 – Contract Closeout.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five (5) years experience.
- B. Installer Qualifications: Acceptable to manufacturer with experience on at least five (5) projects of similar nature in past five (5) years.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of Section 01600 – Material and Equipment.

1.09 START-UP/TESTING AND MAINTENANCE SERVICE

- A. The Factory/Manufacturer shall perform start-up/testing of units.
- B. The Factory/Manufacturer shall provide City training upon completion of project.
- C. The Factory/Manufacturer shall provide the required service and maintenance of units as recommended by the Factory/Manufacturer for a period of one (1) year from the date of final completion acceptance by the City

1.10 WARRANTY

- A. Comply with provisions of Section 01010 – Summary of Work.
- B. Labor, materials and refrigerant for chilled water system specified shall be warranted free from defects for a period of one (1) year after final completion acceptance by the City. Chilled water system failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the City. The contractor shall respond to the City's request for warranty service within 24 hours during customary business hours.
- C. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the City, the City shall sign certificates certifying that the chilled water system's operation has been tested and accepted in accordance with the terms of this specification. The date of City's acceptance shall be the start of warranty.

1.11 REGULATORY REQUIREMENTS

- A. Comply with ARI Standard 550/590-2003 for testing and ratings of Water Chilling Packages using the Vapor Compression Cycle.
- B. Conform to ANSI/UL 1995 for construction of unit
- C. Comply with codes, laws and ordinances in force at local municipality.

PART 2 PRODUCTS

2.01 SUMMARY

- A. The contractor shall furnish and install units as shown and scheduled in the plans. The units shall be installed in accordance with this specification and produce the specified performance in accordance with ARI Standard 550/590-2003.

2.02 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Napps Technology Corporation
- B. Substitutions: Under provisions of this Section.

2.03 EQUIPMENT

- A. NWC-40 Scroll Water Cooled Chiller

2.04 COMPRESSOR AND MOTOR

- A. The compressor(s) shall be scroll mounted on vibration isolators.
- B. Lubrication System: Oil distribution system shall include an oil level sight glass and arranged to ensure adequate lubrication during starting, stopping, and normal operation.
- C. Motor: Constant speed 3600 rpm, suction gas cooled, winding thermostats for motor protection and designed for across the line start.

2.05 EVAPORATOR

- A. Provide evaporator of brazed plate design. Water side shall have only 1 entering and 1 leaving connection. Unit shall feature factory selected and installed 20 mesh strainer on evaporator inlet.
- B. Design, test and stamp refrigerant side maximum working pressure for 600 psig (min) in accordance with ANSI/ASME SEC 8.
- C. Design and test water side working pressure for 600 psig (min).
- D. Insulate with 0.5 inch (20mm) thick minimum flexible insulation with a K value of 0.26.
- E. Provide factory selected and installed integral water strainer, Victaulic connections, and factory installed water temperature sensors for both entering and leaving chilled water.

2.06 CONDENSER

- A. Provide condensers of shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads and enhanced copper tubes expanded into tube sheets.
- B. Provide removable water heads and mechanically cleanable and replaceable tubes.
- C. Provide condenser with one entering and one leaving water connection. Provide field manifolding and water regulating valves, provide (1) factory installed electronic proportional valve for each circuit. Water regulating valves must be controlled by unit controller for optimum unit performance.
- D. Design and test refrigerant side for 600 psig working pressure (minimum).
- E. Provide internally enhanced condenser tubes with minimum nominal tube wall thickness of .025 inches.

2.07 REFRIGERANT CIRCUIT

- A. Provide refrigerant circuits, factory supplied and piped.
- B. Provide for each refrigerant circuit:
 - 1. Liquid line solenoid valve.
 - 2. Filter dryer for water cooled units.
 - 3. Combination liquid line sight glass and moisture indicator.
 - 4. Charging port(s).
 - 5. Insulated suction line.

2.08 CONTROLS

- A. Locate on the chiller, a unit control panel, containing a starter section and a controls section with a unit microprocessor controller.
- B. Provide the following devices in starter section:
 - 1. Top or bottom access for power wiring.
 - 2. Factory wired single point power connection to <<POWER_HOOK-UP_CONNECTION>> (Non-fused disconnect switch or power distribution block).
 - 3. Grounding lug for customer connection.
 - 4. Control power transformer with primary and secondary fused protection.
 - 5. Arrangement for across-the-line start.
 - 6. Three-phase voltage monitor providing protection against common voltage faults such as unbalanced, over/under voltage, phase loss, reversal and incorrect sequencing. Fault must require a manual reset.
- C. Provide the following devices in the control section:

1. Microprocessor based controller with display and keypad on exterior of control panel door. Microprocessor must have multiple levels of password security.
 2. Electronic expansion valve microprocessor controller interface boards with dedicated control power transformer.
 3. Terminal strip with provision for field connection of Remote Run / Stop contacts and Chilled Water Flow Proving device contacts: unit controls shall provide a contact output to control the water circulating pumps.
 4. Control wiring and terminal strips arranged in such a way as to facilitate ease of service and diagnosis.
- D. Provide a microprocessor display and keypad accessible from unit exterior with a minimum of the following:
1. 128 x 64 dot pixel display screen capable of displaying all unit control set points, fault and alarm conditions with history, and operating conditions.
 2. 5.25" wide x 6.5" high keypad.
 3. RS-232 port allowing the user to interactively communicate with the microprocessor controller.
 4. Display must be capable of displaying all unit set points, faults and alarms, and operating conditions.
- E. Microprocessor controller must have the following:
1. Design for hostile environment of HVAC/R industry.
 2. Displays, alarms and other interfaces must be accomplished in a clear and simple language that informs the user as to the status of the controller.
 3. Proportional, integral, derivative (PID) chilled water temperature control.
 4. Controller must have the ability through BMS input for Remote Run/Stop, Leaving Chilled Water Temperature Reset and Load Shedding.
 5. Microprocessor must be capable of LonTalk or BACnet MS/TP communication using an optional adaptor.
 6. Display readouts shall include operating modes, water temperature set point, operating temperatures, and diagnostic information. Provide access and operation of display without the need to open or remove unit panels.
 7. Should a fault occur that results in a lock out condition, the controller must record 30 seconds of prior operating history for fault analysis.
- F. Provide the following safety controls and diagnostic display for automatic shutdown of the machine, requiring manual reset:
1. Low chilled water temperature.

2. High condenser refrigerant discharge pressure (one retry allowed before manual lockout).
 3. Low suction pressure.
 4. Low refrigerant suction superheat.
 5. Emergency Stop.
- G. Provide the following safety controls for automatic shutdown of the machine with automatic reset:
1. Chilled water flow proving device. Under no circumstances should the flow proving devices be used to start and stop chiller during normal operation. Flow proving device is *required and must be field installed by others*.

2.09 BUILDING MANAGEMENT SYSTEM

- A. Provide a 0 to 5 VDC signal using a shielded cable to reset to allow remote reset of Leaving Chilled Water Temperature.

2.10 CIRCULATING PUMPS

- A. Manufacturer and Product: Bell & Gossett, 1531 Series
- B. Size: 1-1/2BC
- C. End suction, close-coupled and foot mounted.
- D. Bronze fitted.
- E. Provide with TEFC premium efficiency motor.
- F. Provide with Bell and Gossett triple-duty valve.

2.11 BUFFER TANK

- A. Manufacturer and Product: Cemline Corporation, CWB Series
- B. Tank Volume: 300 gallons
- C. Provide with 1-1/2 inch thick Arm-A-Flex insulation, stucco embossed aluminum jacket and Bell & Gossett No. 107A air vent.
- D. Tank shall be ASME certified.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with work in accordance with Section 01710

3.02 PREPARATION

- A. Remove refrigerant from existing chiller and transfer to approved storage containers per EPA guidelines.

- B. Remove and dispose of existing refrigerant and oil from job site.
- C. Provide minimum 4-inch concrete pad for water chiller, circulation pumps and buffer tank

3.03 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions, State Code and City of Milwaukee Ordinances and approved shop drawings.
- B. Arrange piping for easy dismantling to permit condenser tube cleaning.
- C. Provide ¾" Crane #58 drain valves with composition discs and hose threads at bottom of all low points in the system.
- D. Provide air chambers and manual air vents at all high points of the system
- E. The refrigerant rupture relief line shall be carbon steel or copper type M up to the connection leaving the building. Modify the piping to accommodate state and local codes. The piping shall incorporate a flanged woven stainless steel vibration isolator to reduce the transfer of vibration to the building. A drain and sensing port for the purposes of the sensing of the presences of refrigerant leaks shall be located near the bottom elevation of the vent line.
- F. Provide cross-connected pressure gauge for the purposes of determining flow. Assembly shall include a single 3½ inch bottom mount pressure gauge with 1 pound increments, ¼-inch stainless steel tubing, and isolation valves. Install assembly between inlet and outlet of evaporator.
- G. Provide cross-connected pressure gauge for the purposes of determining flow. Assembly shall include a single 3½ inch bottom mount pressure gauge with 1 pound increments, ¼-inch stainless steel tubing, and isolation valves. Install assembly between inlet and outlet of each condenser.

3.04 INSTALLATION – Circulating Pumps

- A. Provide woven stainless steel vibration isolators on the suction and discharge piping.
- B. Provide eccentric reducer on pumps inlet and concentric increaser on pumps discharge.
- C. Provide Y-strainer in pump's suction piping. Strainer shall have a ball valve with threaded hose connection for filling and draining.
- D. Provide cross-connected pressure gauge for the purposes of determining flow. Assembly shall include a single 3½ inch bottom mount 0 to 60 psi pressure gauge with 1 pound increments, ¼-inch stainless steel tubing, and isolation valves. Install assembly between inlet and outlet of each chilled water pump.
- E. Provide thermometer on pump outlet connection.

3.05 INSTALLATION – Buffer Tank

- A. Provide air vent on top of tank and pipe air outlet to ground elevation. Piping from vent to ground shall be well supported.
- B. Provide drain valve on bottom of tank. Provide a threaded hose connection on pipe outlet for draining. Valve and piping shall be the same size as the tank's drain connection.
- C. Provide thermometer on inlet connection.

3.06 FIELD QUALITY CONTROL

- A. Tests: Laser align circulating pumps after installation to verify correct alignment.
- B. Inspections:

3.07 ADJUSTING

- A. Adjust parts for smooth uniform operation.

3.08 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods, which may damage finish [surface] or surrounding construction.

END OF SECTION

SECTION 15830
STEAM TERMINAL UNITS AND SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Convectors
 - 2. Fin Tube
 - 3. Unit Heaters
 - 4. Steam & Steam Condensate Specialties

1.02 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Product Data:
 - 1. Submit manufacturer’s descriptive literature and product specifications for each product.

1.03 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum five years experience.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of Section 01600 – Material and Equipment.

1.07 GUARANTEE

- A. Comply with provisions of Section 01010 – Summary of Work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sterling Hydronics of Westfield, MA:

B. Substitutions: Under provisions of Section 01600

2.02 EQUIPMENT

A. Convector

1. Model: SFG-A; sloped outlet with stamped louvers; stamped louvered inlet
2. Dimensions: See Schedule on Drawings
3. Material: 18 gauge Front and 20 gauge Liner; CRS
4. Finish: Baked Enamel; SB-7 Soft Dove
5. Coil: Bronze header ¾" NPT with copper tube/aluminum fins
6. Access Doors: Provide

B. Recessed Convector

1. Model: FWG-A; front outlet with stamped louvers; stamped louvered inlet
2. Dimensions: See Schedule on Drawings
3. Material: 18 gauge Front and 20 gauge Liner; CRS
4. Finish: Baked Enamel; SB-7 Soft Dove
5. Coil: Bronze header ¾" NPT with copper tube/aluminum fins
6. Access Doors: Provide

C. Fin Tube

1. Model: Versa-Line; JVA-T14
2. Enclosure: flat top; top outlet with stamped louvers
3. Material: 16 gauge CRS
4. Finish: Baked Enamel; SB-7 Soft Dove
5. Element: Copper tube/aluminum fins

D. Unit Heater

1. Model: HS; horizontal with steam coil
2. Casing: 20 gauge die formed steel
3. Coil: copper tube/aluminum fins
4. Louvers: horizontal and adjustable

2.03 ACCESSORIES

- A. F & T Steam Trap
 - 1. Bestobell; FT Series
- B. Thermostatic Steam Trap
 - 1. Spirax-Sarco
- C. Vacuum Relief Valve
 - 1. Watts N36; automatic

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with work in accordance with Section 01710
- B. Verify that adequate space is available for installation of terminal units.

3.02 PREPARATION

3.03 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions, State of Wisconsin standards and approved shop drawings.

3.04 ADJUSTING

- A. Adjust parts for smooth uniform operation.

3.05 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods, which may damage finish or surrounding construction.

END OF SECTION

SECTION 15855
AIR HANDLING UNITS WITH COILS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Air Handling Units.

1.02 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Product Data:
1. Submit manufacturer’s descriptive literature and product specifications for each product.
- C. Shop Drawings:
1. Indicate mechanical room layout of air-handling units, supports, ductwork and piping. Include field measured dimensions.
- D. Substitutions:
1. City will only consider substitutions requests for this section during the period of time starting with the project’s advertised date and ending two (2) weeks prior to the project’s bid opening date.
 2. An addendum will be issued for any and all approved substitutions.
 3. Requests for substitution shall include the following information:
 - a) Manufacturer’s descriptive literature and specifications for the product line.
 - b) Full Product Submittal which shall include:
 - (1) Product Data
 - (2) Performance Data based on design information shown in drawings
 - (3) Mechanical Specifications
 - (4) As-Built Drawings with dimensions
 - (5) Fan curves
 - (6) Acoustical Data
 - (7) Accessories
 - (8) Field Wiring

1.03 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.05 QUALITY ASSURANCE

- A. Unit shall be UL Listed.
- B. Air-handling performance data shall be certified in accordance with AHRI Standard 430.
- C. Unit sound performance data shall be provided using AHRI Standard 260 test methods and reported as sound power.
- D. Coil performance shall be certified in accordance with AHRI Standard 410.
- E. Installer: Acceptable to manufacturer with experience on at least five (5) projects of similar nature in past five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of Section 01600 – Material and Equipment.
- B. Indoor units shall be shipped on an integral base frame (variable from the standard 2.5" to 8" height) for the purpose of mounting units to a housekeeping pad and providing additional height to properly trap condensate from the unit.
- C. Indoor air handling units shall be shipped stretch-wrapped to protect unit from in-transit rain and debris.
- D. Contractor is responsible for long-term storage.

1.07 START-UP/TESTING AND MAINTENANCE SERVICE

- A. The Factory/Manufacturer shall perform start-up/testing of units.
- B. The Factory/Manufacturer shall provide the required service and maintenance of units as recommended by the Factory/Manufacturer for a period of one (1) year from the date of final completion acceptance by the City.

1.08 WARRANTY

- A. Comply with provisions of Section 01010 – Summary of Work.
- B. Labor and materials for air-handling units specified shall be warranted free from defects for a period of one (1) year after final completion acceptance by the City. Air-handling unit failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the City. The Contractor shall respond to the City's request for warranty service within 24 hours during customary business hours.

- C. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the City, the City shall sign certificates certifying that the air-handling unit's operation has been tested and accepted in accordance with the terms of this specification. The date of City's acceptance shall be the start of warranty

1.09 START-UP AND MAINTENANCE SERVICE

- A. The Factory/Manufacturer shall perform start-up of units.
- B. The Factory/Manufacturer shall provide the required service and maintenance of units as recommended by the Factory/Manufacturer for a period of one (1) year from the date of final completion acceptance by the City.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers and Model:
 - 1. Trane
 - a) Performance Climate Changer
- B. Substitutions: Under provisions of this Section.

2.02 EQUIPMENT

- A. General
 - 1. Unit Construction
 - a) All unit panels shall be 2-inch solid, double-wall construction to facilitate cleaning of unit interior. Unit panels shall be provided with a mid-span, no-through-metal, internal thermal break. Casing thermal performance shall be such that under 55°F supply air temperature and design conditions on the exterior of the unit of 81°F dry bulb and 73°F wet bulb; condensation shall not form on the casing exterior.
 - b) Units shall have an integral 2.5-inch base frame.
 - c) All exterior and interior indoor AHU panels will be made of galvanized steel.
 - 2. Unit Paint
 - a) External surface of the unit casing shall be painted at the factory. Units supplied with factory-painted exterior casing shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Unit casing exterior shall be provided with manufacturer's standard color.
 - 3. Casing Deflection

- a) The casing shall not exceed 0.0042 inch deflection per inch of panel span at 1.5 times design static pressure up to a maximum of +8 inches w.g. in all positive pressure sections and -8 inches w.g. in all negative pressure sections.
- b) The unit floor shall be of sufficient strength to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042 inch per inch of panel span.

4. Insulation

- a) Panel insulation shall provide a minimum thermal resistance (R) value of 13 ft²-h-°F/Btu throughout the entire unit. Insulation shall completely fill the panel cavities in all directions so that no voids exist and settling of insulation is prevented. Panel insulation shall comply with NFPA 90A.

5. Drain Pan

- a) All cooling coil sections shall be provided with an insulated, double-wall, stainless steel drain pan. To address indoor air quality (IAQ), the drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes promoting positive drainage to eliminate stagnant water conditions. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition. All drain pan threaded connections shall be visible external to the unit. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum of 2-1/2" beyond the base to ensure adequate room for field piping of condensate drain traps. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.

6. Access Door Construction

- a) Access doors shall be 2-inch double-wall construction. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage. Surface-mounted handles shall be provided to allow quick access to the interior of the functional section and to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance. Handle hardware shall be designed to prevent unintended closure. Access doors shall be hinged and removable for quick, easy access. Hinges shall be

interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

- b) All doors shall be a minimum of 60-inches high when sufficient height is available, or the maximum height allowed by the unit height.
 - c) Door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.
- B. Mixing Section: A mixing section shall be provided to support the damper assembly for outdoor, return, and/or exhaust air.
- 1. Dampers
 - a) Dampers shall modulate the volume of outdoor, return, or exhaust air. The dampers shall be of double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on all blades. The blades shall rotate on stainless-steel sleeve bearings. The dampers shall be rated for a maximum leakage rate of 4 cfm/ft² at 1 in. w.g. complying with ASHRAE 90.1 maximum damper leakage. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Dampers shall be arranged in an opposed-blade configuration.
 - 2. Filters
 - a) Mixing sections shall be provided with filter racks.
 - b) 2-inch pleated media filters made with 100% synthetic fibers that are continuously laminated to a supported steel-wire grid with water repellent adhesive shall be provided. Filters shall be capable of operating up to 625 fpm face velocity without loss of filter efficiency and holding capacity. The filters shall have a MERV 8 rating when tested in accordance with the ANSI/ASHRAE Standard 52.2.
 - 3. Provide an access door on both sides of mixing section.
- C. Coil Section
- 1. The coil section shall be provided complete with horizontal coil and coil holding frame. Coil section side panels shall be easily removable to allow for removal and replacement of coils without impacting the structural integrity of the unit. The coils shall be installed such that headers and return bends are enclosed by unit casings. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

2. Water Coils (Type UW)

- a) The coils shall have aluminum fins and seamless copper tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of the tubes. The coil casing shall be galvanized steel.
- b) The coils shall be proof-tested to 300 psig and leak-tested under water to 200 psig. Coil performance data and coils containing water or ethylene glycol shall be certified in accordance with AHRI Standard 410.
- c) Headers are constructed of round copper pipe or cast iron.
- d) Tubes are 1/2" [13mm] OD 0.016" [0.406mm] thick copper
- e) Provide a galvanized steel coil casing.
- f) Provide a medium sized section.

3. Steam Coils (Type NS)

- a) The coils shall have aluminum fins and seamless copper tubes. The fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of the tubes. The coil casing shall be galvanized steel.
- b) Non-freeze, steam-distributing-type coils shall be provided. Steam coils shall be pitched in the unit for proper drainage of steam condensate from coils. The coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water. Headers are to be constructed of cast iron. Inner tubes shall have orifices that ensure even steam distribution throughout the full length of the outer tube. Orifices shall be directed toward the return connections to ensure that the steam condensate is adequately removed from the coil. Coil performance data shall be certified in accordance with AHRI Standard 410.
- c) Tube construction shall be a 11/16" OD, 0.031" [0.79mm] copper inner tube with a 1" OD, 0.031" [0.79mm] copper outer tube.
- d) Provide a galvanized steel coil casing.
- e) Provide a small-sized section.

D. Access/Inspection/Turning Section

- 1. A section shall be provided to allow additional access/inspection of unit components and space for field-installed components as needed. An access door shall be provided for easy access. All access sections shall be complete with a double-wall, removable door downstream for inspection, cleaning, and maintenance. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively.

All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.

2. Provide medium-sized access/inspection section.
3. Provide an access door on both sides of access/inspection section.

E. Fan Section (Type AF)

1. The fan type shall be provided as required for stable operation and optimum energy efficiency. The fan shall be a double-width, double-inlet, multiblade-type, airfoil (AF) fan, class 2. AHU-1 shall have a 12-inch diameter and AHU-2 shall have an 18-inch diameter. The fan shall be equipped with self-aligning, antifriction bearings with an L-50 life of 200,000 hours, as calculated per ANSI/AFBMA Standard 9. For any bearing requiring relubrication, the grease line shall be extended to the fan support bracket on the drive side. The fan shall be statically and dynamically balanced at the factory as a complete fan assembly (fan wheel, motor, drive, and belts). The fan shaft shall not exceed 75 percent of its first critical speed at any cataloged speed. Fan wheels shall be keyed to the fan shaft to prevent slipping. The fan shafts shall be solid steel. The fan section shall be provided with an access door on the drive side of the fan. Fan performance shall be certified as complying with AHRI Standard 430. AHU-1 shall have a 12-inch diameter, class 2.
2. Motor Frame
 - a) The motor shall be mounted integral to the isolated fan assembly and furnished by the unit manufacturer. The motor is mounted inside the unit casing on an adjustable base to permit adjustment of drive belt tension. The motor shall meet or exceed all NEMA Standards Publication MG 1 requirements and comply with NEMA Premium efficiency levels when applicable except for fractional horsepower motors which are not covered by the NEMA classification. The motor shall be T-frame, squirrel cage with size, type, and electrical characteristics as shown on the equipment schedule. Motor shall be ODP type.
3. Two-Inch Spring Isolators
 - a) The fan and motor assembly shall be internally isolated from the unit casing with 2-inch (50.8 mm) deflection spring isolators, furnished and installed by the unit manufacturer. The isolation system shall be designed to resist loads produced by external forces, such as earthquakes, and conform to the current IBC seismic requirements.

4. Drive Service Factor

- a) The drives shall be constant speed with fixed-pitch sheaves. The drives shall be selected at a minimum 50 percent larger than the motor brake horsepower (1.5 service factor).
- b) Starter/VFD shall be mounted externally in a NEMA Type 1 enclosure with a durable painted finish on the supply fan section. An external disconnect shall be mounted through-the-door to the starter/VFD to disconnect full power from starter/VFD.

5. Combination VFD/ Disconnect

- a) A combination Variable Frequency Drive (VFD) / disconnect shall be provided. A single VFD shall be provided to ensure proper operation and to optimize operating life.
- b) Each VFD / disconnect shall be properly sized, factory mounted in a full metal enclosure, wired to the fan motor, and commissioned to facilitate temporary heating, cooling, ventilation, and/or timely completion of the project. VFD / disconnects shall include a circuit breaker disconnect with a through-the-door interlocking handle that is spring loaded and designed to rest only in the full "ON" or "OFF" state and shall be lockable in these states. A concealed defeater mechanism shall not allow entry into the enclosure when the handle is in the "ON" position. The VFD package shall also include:
 - (1) Electronic manual speed control
 - (2) Hand-Off-Auto (H-O-A) selector switch
 - (3) Inlet fuses to provide maximum protection against inlet short circuit
 - (4) Current limited stall prevention
 - (5) Auto restart after momentary power loss
 - (6) Speed search for starting into rotating motor
 - (7) Anti-windmill w/DC injection before start
 - (8) Phase-to-phase short circuit protection
 - (9) Ground fault protection

- c) Units with factory-mounted controls shall include power wiring from the VFD panel to the control system transformers, binary output on/off wiring, Emergency Stop input to turn the unit off when fire alarm signal detected, analog output-speed-signal wiring, and all interfacing wiring between the VFD and the direct digital controller.
- d) The VFD shall be UL508C listed and CSA certified and conform to applicable NEMA, ICS, NFPA, & IEC standards.
- e) Provide an access door on both sides of Fan Section

F. MECHANICAL ROOM PAINT

- 1. Acceptable Manufacturers:
 - a) Tnemec Company Incorporated; Kansas City, MO
 - b) Substitutions: Under provisions of Section 01630
- 2. System: Series 1028 Enduratone
- 3. Surface Preparation: Power Wash with biodegradable cleanser
- 4. Prime Coat: HDP Acrylic Polymer (Color) DFT 2.0-3.0
- 5. Finish Coat: HDP Acrylic Polymer (Gray) DFT 2.0-3.0
- 6. Total DFT of Coating System: DFT 4.0-6.0

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean and paint walls of mechanical room.

3.02 INSTALLATION

- A. The air handling units must be rigged, lifted, and installed in strict accordance with the manufacturer's installation, operation, and maintenance manual. The units are also to be installed in strict accordance with the specifications, State of Wisconsin standards and approved shop drawings. Units may be shipped fully assembled or disassembled to the minimum functional section size in accordance with shipping and job site requirements.
- B. All lifting lugs are to be utilized during lift. The lift points will be designed to accept standard rigging devices and be removable after installation. Units shipped in sections will have a minimum of four points of lift.
- C. Provide cross-connected pressure gauge for the purposes of determining flow. Assembly shall include a single 3½ inch bottom mount pressure gauge with 1 pound increments, ¼-inch stainless steel tubing, and isolation valves. Install assembly between inlet and outlet of chilled water coil.

3.03 FIELD QUALITY CONTROL

A. General: Comply with requirements of Section 01450

3.04 ADJUSTING

A. Adjust parts for smooth uniform operation.

3.05 CLEANING

A. Clean as recommended by manufacturer. Do not use materials or methods, which may damage finish or surrounding construction.

END OF SECTION

SECTION 15870
POWER VENTILATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Exhaust Fans
 - 2. Relief Fans

1.02 REFERENCES

- A. Air Movement and Control Association Inc. (AMCA)
- B. American National Standards Institute (ANSI)
- C. National Fire Protection Association (NFPA)
- D. Underwriters Laboratories (UL)

1.03 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Provide dimensional drawings and product data on each fan.
- C. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
- D. Provide outlet velocity and fan's inlet sound power readings for the eight octave bands, decibels, and sones.
- E. Provide manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700 – Contract Closeout.
- B. Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, pulley adjustment, receiving, handling, storage, safety information and cleaning. A troubleshooting guide, parts list, warranty and electrical wiring diagrams.

1.05 QUALITY ASSURANCE

- A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air and sound performance seal.

- B. Classification for Spark Resistant Construction, levels A, B, and C conform to AMCA 99.
- C. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3).
- D. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of Section 01600 – Material and Equipment
- B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
- C. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long-term storage follow manufacturer's installation, operations, and maintenance manual.
- D. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.07 GUARANTEE

- A. Comply with provisions of Section 01010 – Summary of Work.
- B. Manufacturer's Warranty: Submit, for City's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights City may have under contract documents.
 - 1. The warranty of this equipment is to be free from defects in material and workmanship for a period of one (1) year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the manufacturers' option when returned to manufacturer, transportation prepaid.
 - 2. Motor warranty is warranted by the motor manufacturer for a period of one (1) year. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Greenheck, PO Box 410, Schofield, Wisconsin 54476
- B. Substitutions: Under provisions of Section 01600

2.02 Belt Drive Roof Downblast Centrifugal Exhaust Fan – Model GB

- A. General Description
 - 1. Downblast fan shall be for roof mounted applications.
 - 2. Maximum continuous operating temperature is 180 Fahrenheit (82.2 Celsius).
 - 3. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.
- B. Wheel
 - 1. Constructed of aluminum.
 - 2. Non-overloading, backward inclined centrifugal.
 - 3. Statically and dynamically balanced in accordance to AMCA Standard 204-05.
 - 4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.
- C. Motor
 - 1. Motor enclosures: Open dripproof,
 - 2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
 - 3. Mounted on vibration isolators, out of the airstream.
 - 4. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.
 - 5. Accessible for maintenance,
- D. Shafts and Bearings
 - 1. Fan shaft shall be ground and polished solid steel with an anti corrosive coating.
 - 2. Permanently sealed bearings or pillow block ball bearings.
 - 3. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - 4. Bearings are 100 percent factory tested.

5. Fan Shaft first critical speed is at least 25 percent over maximum operating speed.
- E. Housing
1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum.
 2. Shroud shall have an integral rolled bead for extra strength.
 3. Shroud shall be drawn from a disc and direct air downward.
 4. Lower windband shall have a formed edge for added strength.
 5. Motor cover shall be drawn from a disc.
 6. All housing components shall have final thicknesses equal to or greater than preformed thickness.
 7. Curb cap shall have pre-punched mounting holes to ensure correct attachment.
 8. Rigid internal support structure.
 9. Leak proof.
- F. Housing Support and Drive Frame
1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
- G. Vibration Isolation
1. Double studded or pedestal mount true isolators.
 2. No metal to metal contact.
 3. Sized to match the weight of each fan.
- H. Disconnect Switches
1. NEMA 4 rated.
 2. Positive electrical shut-off.
 3. Wired from fan motor to junction box installed within motor compartment.
- I. Drive Assembly
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
 2. Belts: Static free and oil resistant.
 3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 4. The motor pulley shall be adjustable for final system balancing.

5. Readily accessible for maintenance.
- J. Options/Accessories
1. Roof Curb Adaptor/Reducer
 - a) Welded galvanized construction.
 2. Insulated Roof Curb
 - a) Greenheck model GPI.
 - b) Top of roof curb shall be a minimum of 12-inches above finish surface of built-up roof.
 3. Curb Seal
 - a) Rubber seal between the fan and the roof curb.
 4. Damper
 - a) Type: Gravity
 - b) Prevents outside air from entering back into the building when fan is off.
 - c) Balanced for minimal resistance to flow.
 - d) Galvanized frames with prepunched mounting holes.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with work in accordance with Section 01710.
- B. Notify the engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.
- C. Verify that existing exhaust ductwork has been cleaned.

3.02 PREPARATION

- A. Remove existing power ventilator.
- B. Extend and/or modify existing ductwork to create a smooth transition to new power ventilator.
- C. Ensure duct is plumb, sized correctly, and to proper elevation above roof deck. Install duct as specified in air distribution.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's product data, including technical bulletins, product catalog installation instructions and approved shop drawings.

- B. Install roof curb in accordance with manufacturer's product data, including technical bulletins, product catalog installation instructions and approved shop drawings.
- C. Patch built-up roof as required. Patching of roof shall not void roof warranty. Contractor that installed existing roof shall be retained to repair built-up roof at exhaust fan openings.

3.04 SYSTEM STARTUP

- A. Refer to Installation, Operation, and Maintenance Manual (IOM).

3.05 ADJUSTING

- A. Adjust exhaust fans to function properly.
- B. Adjust Belt Tension.
- C. Lubricate bearings.
- D. Adjust drive for final system balancing.
- E. Check wheel overlap.

3.06 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods, which may damage finish or surrounding construction.

END OF SECTION

SECTION 15890
DUCTWORK AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Ductwork – Sheet metal
 - 2. Ductwork – Flexible
 - 3. Dampers
 - 4. Access Doors
 - 5. Insulation Flexible
 - 6. Duct Liner
 - 7. Flexible Connections
- B. Related Sections
 - 1. Section 15940 – Air Outlets and Inlets

1.02 REFERENCES

- A. National Air Duct Cleaners Association, NADCA

1.03 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Product Data:
 - 1. Submit manufacturer's descriptive literature and product specifications for each product.
- C. Shop Drawings:
 - 1. Indicate typical layout including dimensions.
 - 2. Submit drawings showing field measured dimensions.
- D. Control Damper coordination
 - 1. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.

1.04 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.05 QUALITY ASSURANCE

- A. Contractor that cleans exhaust ductwork shall be a member of NADCA.
Personnel performing work shall be certified as Air Systems Cleaning Specialist.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of Section 01600 – Material and Equipment.

1.07 GUARANTEE

- A. Comply with provisions of Section 01010 – Summary of Work.

PART 2 PRODUCTS

2.01 DUCTWORK – SHEET METAL

- A. The material shall be ASTM A525-91A, G60, 0.0179-inch galvanized steel.
- B. The ductwork, accessories, bracing and supports shall be constructed of galvanized steel unless otherwise indicated. Ductwork, turning vanes and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards.
- C. Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards. Ductwork shall be fabricated, reinforced, supported and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a minimum pressure classification of 1 inch.
- D. Furnish either 45-90 tee fittings for round duct takeoffs from round mains, unless otherwise noted on the drawings.
- E. Furnish bellmouth or conical tee fittings for round duct takeoffs from rectangular mains.
- F. Duct sizes shown are net air side face-to-face dimensions required.
- G. Balancing dampers shall have 90 percent unobstructed-free area.
- H. For longitudinal seams, use the Pittsburgh lock seam sealed internally with a permanently elastic sealer such as Ductmate 5511M Mastic.

I. Elbows

1. Rectangular Ductwork

- a) Fit square elbows with turning vane side rails.
- b) Shop fabricate single blade turning vanes of same material as ductwork.
- c) Fabricate with equal inlet and outlet areas.
- d) Rectangular radius elbows with inside radius of $\frac{3}{4}$ of duct width in direction of turn.
 - (1) Provide one (1) splitter vane in rectangular radius elbows.

2. Round Ductwork

- a) Furnish with centerline radius of 1.5 times duct diameter.

J. Plenums

1. Fabricate from minimum 16-gauge metal of the same material as the ductwork.
2. Brace with a frame of the same material for rigidity.
3. Line with sound attenuation material.

2.02 DUCTWORK – FLEXIBLE

- A. Shall meet UL Standard 181-90 and NFPA Standard 90A and 90B.
- B. Duct shall be factory made and composed of: a CPE liner duct permanently bonded to a coated spring steel wire helix and supporting a fiberglass insulating blanket. Low permeability outer vapor barrier of fiberglass reinforced film laminate shall complete the composite.
- C. Insulating Value: $R = 4$ minimum.
- D. Products and Manufacturers:
 1. Pro Series M-KE by Thermaflex
 2. Approved Equal

2.03 DAMPERS

A. Manual Balancing; Round

1. Frame and blade shall be fabricated from the same material as the ductwork. Minimum thickness of material shall be 20 gauge. Frame shall be reinforced with two (2) rolled ribs.
2. Axle shall be $\frac{3}{8}$ " sq. plated steel. Bearings shall be acetal sleeve type.
3. Operator shall be $\frac{3}{8}$ " sq. locking manual quadrant.

4. Provide standoff bracket for dampers that are installed in ducts with external insulation.
5. Products and Manufacturers:
 - a) MBDR-50 by Greenheck
 - b) Approved Equal

B. Manual Balancing; Rectangular

1. Frame and Blades shall be fabricated from the same material as the ductwork. Frame shall be fabricated from 5" x 1" 20 gauge channel. Minimum thickness of blades shall be 16 gauge.
2. Linkage shall be concealed in the jamb. Linkage shall operate the blades in an "opposed blade" manner.
3. Axles shall be ½" dia. plated steel. Bearings shall be acetal sleeve type.
4. Control shaft shall be ½" diameter plated steel.
5. Operator shall be ½" diameter locking manual quadrant.
6. Provide standoff bracket for dampers that are installed in ducts with external insulation.
7. Products and Manufacturers:
 - a) MBD-15 by Greenheck
 - b) Approved Equal

C. Backdraft; Rectangular

1. Pressure Rating of 1.0 in. wg differential pressure.
2. Frame shall be 18 ga. galvanized steel, Blades shall be 0.025 in. aluminum with extruded vinyl blade seals, Axles shall be 3/16-inch diameter plated steel, Bearings shall be acetal sleeve type and linkage shall have spring assisted opening.
3. Products and Manufacturers:
 - a) WD-100 Series by Greenheck
 - b) Approved Equal

2.04 ACCESS DOORS

- A. 12-inch by 12-inch with a gasket around the perimeter.
- B. Panels shall be hinged, insulated and fabricated of same material as ductwork or galvanized in fiberglass ductboard.
- C. On smaller ductwork, furnish a separate size 8-inch by 8-inch access door.

D. Products and Manufacturers:

1. Ventlok
2. Duro-Dyne
3. Approved Equal

2.05 INSULATION – FLEXIBLE

- A. Thickness: 1-1/2 inch with installed minimum R-value of 4.2.
- B. Density: ¾ pound per cubic foot.
- C. FSK Facing: Maximum vapor transmission rate of 0.02 perm.
- D. UL Flame spread and smoke development rating of 25/50.
- E. Products and Manufacturers:
 1. Manville; Type 75 FSK
 2. Owens Corning
 3. Approved Equal

2.06 DUCT LINER

- A. Rectangular Ductwork: 1 inch thick, semi-rigid fiberglass with factory coated edges.
- B. Round Ductwork: 1-inch thick rigid round fiberglass up to 24-inch diameter ducts, and 1-inch semi-rigid fiberglass for ducts larger than 24-inch diameter.
- C. NRC of 0.70 or greater based on Type A mounting.
- D. 1.5 pcf density and an R-value of 4 minimum.
- E. Flame spread/smoke development rating of 25/50.
- F. Attach semi-rigid liner with fire-resistant adhesive and Duro-Dyne welded pin fasteners with NC-1 nylon stop clips.
- G. Adhesive strips at all butt joints unless factory coated edges are used.
- H. Products and Manufacturers:
 1. Manville; Permacote or Spiracoustic
 2. Owens Corning; duct liner
 3. Approved Equal

2.07 FLEXIBLE CONNECTIONS

- A. The fabric shall be air-tight, water-tight, fire retardant and mildew resistant.
- B. Flexible connections shall be in accordance with the requirements of UL Standard #214 and NFPA Bulletin #90A.

- C. Fabric for flexible connections protected from the sunlight and the weather shall be suitable for a temperature range of -20°F to 200°F and shall have a weight of at least 30 ounces per square yard.
- D. Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10°F to 275°F and shall have a weight of at least 26 ounces per square yard.
- E. Products and Manufacturers:
 - 1. Ventglas by Ventfabrics; for flexible connections protected from sunlight and weather.
 - 2. Ventlon by Ventfabrics; for flexible connections exposed to sunlight or weather.
 - 3. Approved Equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with work in accordance with Section 01710.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions, State of Wisconsin standards and approved shop drawings.
- B. Ductwork – Sheetmetal
 - 1. Ductwork, turning vanes and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards. The locations, arrangement, and sizes of ductwork shall be as indicated on the drawings. The duct sizes indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for internally lined ductwork.
 - 2. Ductwork shall be constructed and installed in accordance with the drawings. The size and location of ductwork can be modified to avoid interference with the building structure, piping systems or electrical work. Ductwork modifications shall be approved by the Milwaukee Water Works. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible. Ductwork located above a suspended ceiling shall have a minimum 8-inch clearance between its bottom surface and the face of the ceiling.
 - 3. A ½ inch diameter drain hole shall be provided in the bottom of vertical ducts that terminate within 24 inches of the finish floor. The bottom of the vertical duct shall slope towards the drain hole.

4. Single-thickness turning vanes shall be provided in turns greater than or equal to 45 degrees.
5. Install sheet metal work and flexible ductwork in accordance with the latest edition of the SMACNA “HVAC Duct Construction Standards”.
6. Cross-break horizontal surfaces of rectangular metal ducts.
7. Install additional bracing as required to prevent ballooning or breathing.
8. For interior ductwork, tape joints with Hardcast Lag-Rite tape and bonder or Ray-Chem shrink tape. For exterior ductwork, tape joints with Hardcast outdoor tape and rosin. Tape joints according to the following table.

<u>Pressure Class (in w.c.)</u>	<u>Sealing Required</u>
Less than or equal to 2	Transverse Joints
Greater than 2	Transverse joints and longitudinal seams

9. Seal joints of ductwork in accordance with manufacturer’s instructions.
10. Provide balancing dampers for grilles and diffusers in the branch duct as near the main as possible. Add or remove balancing dampers as requested by the air balancing firm for necessary control of air.
11. Make duct size transitions with the maximum inclusive angle of 30 degrees, unless otherwise indicated on the drawings.
12. Make offsets with maximum angle of 45 degrees.

C. Ductwork – Flexible

1. Flexible ductwork shall not exceed 6 feet in length.
2. Flexible ductwork shall be installed in a straight line and fully expanded.
3. Install between branch duct and ceiling diffusers and grilles, maximum 6-foot length.
4. Attach to duct and terminal device with stainless steel clamps and duct sealer.
5. Install without sags, kinks, sharp offsets or elbows.
6. Coat ends on the inside to a depth of 2 inches with duct sealer, slip over the male collar and clamp in place.

D. Access Doors

1. Install in accordance with manufacturer’s instructions at each duct mounted fire damper, manual balancing dampers, duct mounted smoke or ionization detector, electric duct heater, motorized damper and sail switch.

E. Insulation

1. The contractor shall furnish and install all insulation materials as required and as specified herein for the ductwork. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces that are to be insulated shall be cleaned and dried. Insulation shall be kept clean and dry and shall not be removed from the factory container until it is installed. Packages or factory containers shall have the manufacturer's stamp or label bearing the name of the manufacturer and description of the contents.
2. Firmly butt at joints with a maximum allowable compression of 25 percent.
3. Overlap seams a minimum of 2 inches.
4. Finish seams with appropriate 3-inch minimum width pressure sensitive tape or glass fabric and vapor retardant mastic.
5. For rectangular ducts over 18 inches wide, secure duct wrap to the bottom of the ductwork with mechanical fasteners on 18-inch centers.
6. Apply washers without compressing the insulation.
7. Seal seams, joints, penetrations and damage to the facing with vapor-retardant mastic.
8. Install on all supply and return ductwork.
9. Do not install on ducts that are internally lined.
10. Insulation on ductwork shall be terminated at thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their function and or replacement.

F. Duct Liner

1. The liner shall be folded and compressed in the corners of the duct sections or shall be cut and fit to assure overlapping of butted edges. Top and bottom pieces shall lap the sidepieces. Longitudinal seams shall be made only at corners unless the dimensions of ducts and of standard liner product make seams necessary at other locations. The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches on any side, mechanical fasteners shall be used in addition to adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive. The following ducts shall be insulated with a 1-inch thick interior duct liner unless otherwise indicated:
 - a) Air conditioning and heating systems return air system.
 - b) Other ducts were indicated on the drawings.

2. Install in accordance with SMACNA "HVAC Duct Construction Standards" and manufacturer's recommendations.

G. Flexible Connections

1. Ductwork connections to the air handling unit, rooftop unit, fans and where indicated on the drawings shall be made using fabric connectors with sheet metal collars.
2. Minimum 3 inches of fabric shall be exposed.

H. Control Damper

1. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4" larger than damper dimensions and shall be square, straight, and level.
2. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be equal $\pm 1/8"$.
3. Follow manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
4. Install extended shaft or jackshaft per manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
5. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to assure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
6. Provide a visible and accessible indication of damper position on the drive shaft end.
7. Support duct-work in area of damper when required to prevent sagging due to damper weight.
8. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.03 EXHAUST DUCTWORK

- A. Existing exhaust ductwork, grilles and registers shall be cleaned per NADCA recommendations.
- B. Existing fume hood ductwork shall be cleaned per NADCA recommendations.

3.04 ADJUSTING

- A. Adjust parts for smooth uniform operation.

3.05 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods, which may damage finish or surrounding construction.

END OF SECTION

SECTION 15930
VARIABLE AIR VOLUME TERMINAL UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. VAV Fan Powered Terminal Units
 2. VAV Single Duct Terminal Units

1.02 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Product Data:
1. Submit manufacturer's descriptive literature and product specifications for each product.
- C. Shop Drawings:
1. Indicate Ground Floor and Second Floor layout of VAV terminal units. Indicate distance of straight length of ductwork upstream of VAV terminal unit. Indicate distance between control panels on VAV terminal unit and closest obstruction.
- D. Substitutions:
1. City will only consider substitutions requests for this Section during the period of time starting with the project's advertised date and ending two (2) weeks prior to the project's bid opening date.
 2. An addendum will be issued for any and all approved substitutions.
 3. Requests for substitution shall include the following information.
 - a) Manufacturer's descriptive literature and specifications for the product line.
 - b) Full Product Submittal which shall include:
 - (1) Product data
 - (2) Performance data based on design information shown in drawings
 - (3) Mechanical specifications
 - (4) Drawings with dimensions
 - (5) Accessories

1.03 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.05 QUALITY ASSURANCE

- A. Terminal unit shall be UL listed as an environmental or room air terminal.
- B. Terminal units shall be AHRI 880 -98 certified.
- C. Installer Qualifications: Acceptable to manufacturer with experience on at least five (5) projects of similar nature in past five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of Section 01600 – Material and Equipment.

1.07 WARRANTY

- A. Comply with provisions of Section 01010 – Summary of Work.
- B. Labor and materials for VAV boxes specified shall be warranted free from defects for a period of one (1) year after final completion acceptance by the Owner. VAV box failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the City. The Contractor shall respond to the City's request for warranty service within 24 hours during customary business hours.
- C. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the City, the City shall sign certificates certifying that the VAV boxes' operation has been tested and accepted in accordance with the terms of this specification. The date of City's acceptance shall be the start of warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers and Model:
 - 1. Trane
 - a) Model: VSEF & VCEF
- B. Substitutions: Under provisions of this Section

2.02 VAV FAN POWERED TERMINAL UNITS

- A. Unit Casing
 - 1. Unit casing shall be 22 gauge galvanized steel.
 - 2. Provide a filter on the plenum inlet.

B. Insulation

1. The interior surface of the unit casing shall be acoustically and thermally lined with 1/2", 1.8 lb/cu. ft composite density glass fiber with high density facing. The insulation shall be UL listed and meet NFPA-90A, NFPA- 90B and UL 181 standards. Insulation shall meet the 25/50 smoke developed and flame spread rating (per ASTM E 84 and UL 723). The insulation R-value is 1.9. All cut edges of insulation shall be completely encapsulated in metal to prevent erosion.

C. Air Valve & Fan (Series)

1. The air inlet connection shall be an 18 gauge galvanized steel cylinder sized to fit standard round duct. A multiple point, averaging flow sensing ring shall be provided with balancing taps for measuring airflow within +/- 5% of unit cataloged airflow. Provide a calibration chart with each unit to indicate airflow versus flow sensor pressure differential. The damper blade shall be constructed with a closed cell foam seal mechanically locked between two 22-gauge galvanized steel disks. The damper blade assembly shall be connected through a composite nylon stub axle to a cast zinc shaft supported by self lubricating bearings. The shaft shall be cast with a damper position indicator. The valve assembly shall include a mechanical stop to prevent over stroking.
2. At 4.0" w.g. air valve leakage shall not exceed 1% of cataloged airflow.

D. Motor

1. Single Speed, direct drive induction, permanent split capacitor type. Provide with thermal overload protection. Motors shall be designed specifically for use with an open SCR which is standard. Motors shall accommodate anti-backward rotation at start up. Motor and Fan assembly shall be isolated from terminal unit.

E. Fuse

1. Any electric heat unit with a calculated MCA greater or equal to 30 shall have a fan fuse provided.

F. SCR-Variable Fans Speed Control Switch

1. The SCR speed control device shall allow the operator infinite fan speed adjustment so the fan output may be modified to achieve exact CFM requirements.

G. Factory Wire/Field Mounted Auxiliary Temperature Sensor

1. The auxiliary temperature sensor shall be used in conjunction with the Trane DDC controller to sense duct temperature. When the DDC controller is used with a building automation system, the sensor temperature is reported as status only. When the DDC controller is used in

a stand-alone configuration, the sensor determines the control action of the UCM in a heat/cool changeover system.

2. The factory mounted sensor shall be pre-wired and zip-tied to the control box, where it can be easily cut loose and mounted in the duct.

H. Electric Heat Coil

1. Factory provided and mounted. UL recognized resistance open-type heater, a disc-type automatic thermal primary safety device and manual reset load thermal secondary device. Heater element material shall be nickel-chromium. The heater terminal box shall be provided with 7/8" knockouts for customer power supply. Terminal connections shall be plated steel with ceramic or phenolic insulators. All fan-powered units with electric reheat shall be single-point power connections.

I. Power Disconnect Switch

1. Provide a factory installed interlocking door disconnect switch located on the electric heater control panel.

J. Airflow Switch

1. Provide an air pressure device designed to disable the heater when the unit fan is off.

K. Power Fuse

1. Provide a safety fuse located in the electric heater's line of power to prevent power surge damage to the electric heater.

L. SCR Mounted Electric Heat

1. Provide an SCR electric control device for use with UC400 Programmable BACnet Controller. The SCR serves both as a substitute for magnetic contactors and a RoHS compliant alternative to mercury switches. The SCR allows the operator modulating heat adjustment for precise, silent control of zone temperature.

M. Flanged Connection

1. Provide a rectangular opening on the unit discharge to accept a 90 degree flanged duct work connection.

N. Digital Display Zone Sensor

1. The Digital Display Zone Sensor shall contain a sensing element, which sends a signal to the U.C.M. A Liquid Crystal Display (LCD) displays set point, or space temperature. Sensor buttons shall allow the user to adjust set points, and allow space temperature readings to be turned on or off. The Digital Display Zone Sensor shall also include a communication jack, for use with a portable edit device, and an override button to change the U.C.M. from unoccupied to occupied. The override button shall have a cancel feature, which returns the system to unoccupied mode.

2.03 VAV SINGLE DUCT TERMINAL UNITS

A. Unit Casing

1. Unit casing shall be 22 gauge galvanized steel

B. Insulation

1. The interior surface of the unit casing shall be acoustically and thermally lined with 1/2", 1.8 lb/cu. ft composite density glass fiber with high density facing. The insulation shall be UL listed and meet NFPA-90A, NFPA- 90B and UL 181 standards. Insulation shall meet the 25/50 smoke developed and flame spread rating (per ASTM E 84 and UL 723). The insulation R-value is 1.9. All cut edges of insulation shall be completely encapsulated in metal to prevent erosion.

C. Air Valve Round

1. The air inlet connection shall be an 18 gauge galvanized steel cylinder sized to fit standard round duct. A multiple point, averaging flow sensing ring shall be provided with balancing taps for measuring within +/- 5% of unit cataloged airflow. An airflow versus pressure differential calibration chart shall be provided. The damper blade shall be constructed of a closed cell foam seal mechanically locked between two 22 gauge galvanized steel disks. The damper blade assembly shall be connected through a composite nylon stub axle to a cast zinc shaft supported by self lubricating bearings. The shaft shall be cast with a damper position indicator. The valve assembly shall include a mechanical stop to prevent over stroking.
2. At 4.0" w.g. air valve leakage shall not exceed 1% of cataloged airflow.

D. Factory Wired/Field Mounted Auxiliary Temperature Sensor

1. The auxiliary temperature sensor shall be used in conjunction with the Trane DDC controller to sense duct temperature. When the DDC controller is used with a Building Automation System, the sensor temperature is reported as status only. When the DDC controller is used in a stand-alone configuration, the sensor determines the control action of the UCM in a heat/cool changeover system.
2. The factory mounted sensor shall be pre-wired and zip-tied to the control box, where it can be easily cut loose and mounted in the duct.

E. Electric Heat Coil

1. Factory provided and mounted. UL recognized resistance open-type heater, a disc-type automatic thermal primary safety device and manual reset load thermal secondary device. Heater element material shall be nickel-chromium. The heater terminal box shall be provided with 7/8" knockouts for customer power supply. Terminal connections shall be plated steel with ceramic or phenolic insulators. All fan-powered units with electric reheat shall be single-point power connections.

- F. Power Disconnect Switch
 - 1. Provide a factory installed interlocking door disconnect switch located on the electric heater control panel.
- G. Line Fuse
 - 1. Provide a safety fuse located in the electric heater's line of power to prevent power surge damage to the electric heater.
- H. SCR Modulated Electric Heat
 - 1. Provide an SCR electric control device for use with UC400 Programmable BACnet Controller. The SCR serves both as a substitute for magnetic contactors and a RoHS compliant alternative to mercury switches. The SCR allows the operator modulating heat adjustment for precise, silent control of zone temperature.
- I. Slip & Drive Connection
 - 1. A slip and drive connection on the discharge of the VAV box shall be provided.
- J. Electric Heat Transformer
 - 1. A 40VA or 75VA transformer shall be an integral component of the heater control panel dependent on unit load requirements to provide 24 VAC for controls.
- K. Digital Display Zone Sensor
 - 1. The Digital Display Zone Sensor contain a sensing element, which sends a signal to the U.C.M. A Liquid Crystal Display (LCD) displays set point, or space temperature. Sensor buttons allow the user to adjust set points, and allow space temperature readings to be turned on or off. The Digital Display Zone Sensor also includes a communication jack, for use with a portable edit device, and an override button to change the U.C.M. from unoccupied to occupied. The override button has a cancel feature, which returns the system to unoccupied mode.
 - a) Sensor: The wired display sensor monitors the temperature of the specific building space where it is installed. The sensor displays zone temperature or setpoint occupancy (timed override) system control. A controller in the HVAC system uses the sensor input to maintain the zone at a selected temperature
 - b) Enclosure: The sensor enclosure consists of back plate, cover, security screw and mounting hardware. It provides openings for ventilation. A security screw is located at the bottom of the enclosure and anchors the cover to the back plate to help prevent tampering.

- c) Occupancy: This optional function allows temporary control of the heating and cooling for the zone monitored by the temperature sensor which has reverted to unoccupied mode. Not all systems support this capability.
- d) Setpoint: The setpoint and room temperature can be set to display Fahrenheit or Celsius. The temperature resolution can be selected for tenths, halves, or whole numbers. The sensor can be set to display room temperature or setpoint depending on building owner preference. The sensor ships configured for single setpoint in Fahrenheit, with whole degree resolution. The room temperature is displayed by default for all options.

PART 3 EXECUTION

3.01 PREPARATION

- A. Provide VAV boxes with either left hand or right hand controls as dictated by location of VAV box in field.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions, State of Wisconsin standards and approved shop drawings.
- B. Leave a minimum of 36" on control box side of unit for adequate service access. Allow at least 12" on remaining sides for unit clearance.
- C. A minimum of four to six duct diameters of straight duct work, upstream of the air inlet connection, should be present for optimum airflow measurement performance. Upstream duct work shall be the same diameter as the primary inlet connection.
- D. Provide a 45-90 tee fitting where the inlet duct for the VAV branches off from the main duct.
- E. Provide a distance equal to at least four to six duct diameters between runout fittings.

3.03 ADJUSTING

- A. Adjust parts for smooth uniform operation.

3.04 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods, which may damage finish or surrounding construction.

END OF SECTION

SECTION 15940
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Ceiling Diffusers
 - 2. Ceiling Return Grilles
 - 3. Registers and Grilles
 - 4. Louvers
- B. Related Sections
 - 1. Section 15890 – Ductwork and Accessories

1.02 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Performance data shall be furnished that adheres to ANSI/ASHRAE Standard 70-1991.
- C. Product Data:
 - 1. Submit manufacturer's descriptive literature and product specifications for each product.
 - 2. Include data to indicate:
 - a) NC Sound data
 - b) Static pressure loss data
 - c) Throw data

1.03 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of Section 01600 – Material and Equipment.

1.06 GUARANTEE

- A. Comply with provisions of Section 01010 – Summary of Work

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Titus; Plano TX
- B. Substitutions: Under provisions of Section 01630
 - 1. Substitutions shall provide Air Diffusion Performance Index (ADPI) calculations for each ceiling diffuser and supply register.

2.02 PLENUM SLOT DIFFUSERS

- A. Model: TBDI-30; insulated plenum; adjustable Modulinear control.
- B. Finish: standard; black pattern controllers.
- C. See schedules in contract drawings for additional information.

2.03 ROUND CEILING DIFFUSERS

- A. Model: TMR
- B. Finish: standard; #26 White.
- C. See schedules in contract drawings for additional information.

2.04 LOUVERED SUPPLY REGISTERS

- A. Model: 300FS; double deflection; short front blade, 0° deflection.
- B. Finish: standard; #26 White.
- C. See schedules in contract drawings for additional information.

2.05 RETURN GRILLE - WALL

- A. Model: 350FL; ¾-inch spacing, 35° deflection.
- B. Finish: standard; #26 White.
- C. See schedules in contract drawings for additional information.

2.06 RETURN GRILLE - CEILING

- A. Model: PAR; perforated face; steel, flush face, round inlet.
- B. Border Type: Three (3).
- C. Finish: standard; #26 White.
- D. See schedules in contract drawings for additional information.

2.07 LOUVER

- A. Manufacturer and Product: Greenheck ESJ-401.
- B. Extruded aluminum, 4-inches deep.
- C. See schedules in contract drawings for additional information.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with work in accordance with Section 01710.

3.02 INSTALLATION

- A. Install diffusers, grilles and registers tight on their respective mounting surfaces, level plumb and true with room dimensions.
- B. TMR round ceiling diffusers shall be set to Position No. 1.
- C. Provide a balancing damper at the branch takeoff for each ceiling diffuser.
- D. Flexible duct between the slot/round ceiling diffusers and the rigid ductwork shall be limited to 4'-0".
- E. Provide appropriate frame to adapt to mounting surface.

3.03 ADJUSTING

- A. Adjust parts for smooth uniform operation.

3.04 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods, which may damage finish or surrounding construction.

END OF SECTION

SECTION 15950**CONTROL****PART 1 GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Direct Digital Controls for HVAC system.

1.02 CODES AND STANDARDS**A. Work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of local, state and federal authorities. As a minimum, the installation shall comply with the current editions in effect thirty (30) days prior to receipt of bids of the following codes**

1. National Electric Code (NEC)
2. International Building Code (IBC)
3. International Mechanical Code (IMC)
4. Underwriters Laboratories: Products shall be UL-916-PAZX listed.
5. ANSI/ASHRAE Standard 135-2004 (BACnet)
6. ISO/IEC 14908-1 (LonTalk)

1.03 DESCRIPTION

- A. The Trane Tracer SC control system shall be as indicated on the drawings and described in the specifications, and consist of a peer-to-peer network of digital building control panels and operator workstation(s). The user interface shall be through any personal computer available on the network. The PC shall provide users an interface with the system through dynamic color graphics of building areas and systems.**
- B. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of systems defined for control on this project.**
- C. The control system shall accommodate simultaneous multiple user operation. Access to the control system data should be limited by operator ID and password. An operator shall be able to log onto any PC on the designated network and have access to all designated data.**
- D. The control system shall be designed such that each mechanical system will operate under stand-alone control. As such, in the event of a network communication failure, or the loss of other controllers, the control system shall continue to independently operate the unaffected equipment.**

- E. Communication between the control panels and all workstations shall be over a high-speed network. All nodes on this network shall be peers. The control system shall have internet connectivity for remote access to the system.

1.04 SYSTEM PERFORMANCE

- A. Performance Standards. The system shall conform to the following:
 1. Page Display. The system shall display a web page will be displayed within [10] seconds of the request.
 2. Page Refresh. The system shall update all within [10] seconds.
 3. Graphic Refresh. The system shall update all dynamic points with current data within [30] seconds.
 4. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be [10] seconds. Analog objects shall start to adjust within [10] seconds.
 5. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current, within the prior [60] seconds.
 6. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed [30] seconds.
 7. Program Execution Frequency. Custom programs shall be capable of running as often as once every second. The contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
 8. Performance. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every [5] seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
 9. Multiple Alarm Annunciation. All users on the network shall receive alarms within [10] seconds of each other.
 10. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.

Table 1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C [±1°F]
Ducted Air	±1.0°C [±2°F]
Outside Air	±1.0°C [±2°F]
Water Temperature	±0.5°C [±1°F]
Delta-T	±0.15°C [±0.25°F]
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Air Flow (terminal)	±10% of reading *Note 1
Air Flow (measuring stations)	±5% of reading
Air Pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air Pressure (space)	±3 Pa [±0.01 "W.G.]
Water Pressure	±2% of full scale *Note 2
Electrical Power	± 5% of reading *Note 3
Carbon Monoxide (CO)	± 5% of reading
Carbon Dioxide (CO ₂)	± 50 PPM

Note 1: (10%-100% of scale) (cannot read accurately below 10%)

Note 2: for both absolute and differential pressure

Note 3: * not including utility supplied meters

1.05 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Contractor shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software to be provided.
- C. Quantities of items submitted shall be reviewed by the City. Such review shall not relieve the contractor from furnishing quantities required for completion.
- D. Provide the City, any additional information or data which is deemed necessary to determine compliance with these specifications or which is deemed valuable in documenting the system to be installed.
- E. Submit the following:
 1. A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.
 2. A schedule of all control valves including the valve size, model number (including pattern and connections), flow, CV, pressure rating, and location.

3. A schedule of all control dampers. This shall include the damper size, pressure drop, manufacturer and model number.
4. Provide manufacturers cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is being submitted to cover. Include:
 - a) Building Controllers
 - b) Custom Application Controllers
 - c) Application Specific Controllers
 - d) Auxiliary Control Devices
 - e) Proposed control system riser diagram showing system configuration, device locations, addresses, and cabling.
 - f) Detailed termination drawings showing all required field and factory terminations. Terminal numbers shall be clearly labeled.
 - g) Points list showing all system objects, and the proposed English language object names.
 - h) Sequence of operations for each system under control. This sequence shall be specific for the use of the Control System being provided for this project.

1.06 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.
- B. These shall be as-built versions of the submittal shop drawings. One set of electronic media including CAD .DWG or .DXF drawing files shall also be provided.
- C. Testing and Commissioning Reports and Checklists.

1.07 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700 – Contract Closeout.
- B. These shall be as-built versions of the submittal product data. In addition to that required for the submittals, the O & M manual shall include:
 1. Names, address and 24-hour telephone numbers of contractors installing equipment, and the control systems and service representative of each.
 2. A listing and documentation of all custom software created using the programming language including the point database. One set of magnetic media containing files of the software and database shall also be provided.

3. One set of electronic media containing files of all color-graphic screens created for the project.
4. Complete original issue documentation, installation, and maintenance information for all third party hardware provided including computer equipment and sensors.
5. Licenses and warranty documents for all equipment and systems.
6. Recommended preventive maintenance procedures for all system components including a schedule of tasks, time between tasks, and task descriptions.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: The control system shall be installed by a local factory Trane office within 50 miles of the project site and provide 24-hour response in the event of a customer call.

1.09 MAINTENANCE SERVICE

- A. The Factory/Manufacturer shall provide the required service and maintenance of controls as recommended by the Factory/Manufacturer for a period of one (1) year from the date of final completion acceptance by the City.

1.10 WARRANTY

- A. Comply with provisions of Section 01010 – Summary of Work.
- B. Labor and materials for control system specified shall be warranted free from defects for a period of one (1) year after final completion acceptance by the City. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the City. The Contractor shall respond to the City's request for warranty service within 24 hours during customary business hours.
- C. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the City, the City shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of City's acceptance shall be the start of warranty.

1.11 OWNERSHIP OF PROPRIETARY MATERIAL

- A. All project-developed hardware and software programs shall become the property of the City. These items include but are not limited to:
 1. Project graphic images
 2. Record drawings
 3. Project database
 4. Project-specific application programming code
 5. All documentation

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Trane.
- B. Substitutions: Under provisions of Section 01630

2.02 MATERIALS

- A. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of one (1) year. The installation shall not be used as a test site for any new products unless explicitly approved by the City's representative in writing. Spare parts shall be available for at least five (5) years after completion of this contract.

2.03 COMMUNICATION

- A. This project shall comprise of a network utilizing high-speed [BACnet] for communications between System Controllers. LonTalk or BACnet MSTP sub-networks shall be used for communications between System Controllers, Custom Application Controllers and Application Specific Controllers.
- B. The City will provide all communication media, connectors, repeaters, network switches, and routers necessary for the internetwork. An active Ethernet jack will be provided adjacent to each System Control Panel and PC Workstation for connection to this network.

All System Controllers shall have an Ethernet communications port for connections with the operator interfaces.

- C. Communications services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows.
 1. Connection of an operator interface device to any one System Controller on the internetwork will allow the operator to interface with all other System Controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all System Controllers shall be available for viewing and editing from any one System Controller on the internetwork.
 2. All database values (i.e., points, software variable, custom program variables) of any one System Controller shall be readable by any other System Controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to a point name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communications services to perform internetwork value passing.
- D. The time clocks in all System Controllers shall be automatically synchronized daily.

2.04 OPERATOR INTERFACE

- A. The City will furnish the PC-based workstations as shown on the system drawings. Each of these workstations shall be able to access all information in the system. These workstations shall reside on the Enterprise-wide network, which is same high-speed network as the System Controllers. The Enterprise-wide network will be provided by the City and supports the Internet Protocol (IP). Workstation information shall be provided through web pages.
- B. Hardware. Each operator workstation shall consist of the following:
 - 1. Personal Computer ,shall have internet explorer 7.0 or higher or Firefox 3.0 or higher.
- C. User Interface
 - 1. Internet Browser. Furnish with either Internet Explorer 7.0 or higher, or Firefox 3.0 or higher. Java 5.0 or higher must also be installed on the PC.
 - 2. User interface. The system user interface shall be web-based graphically orientated. Provide a method for the operator to easily move between web pages. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation of equipment. Animation capabilities shall include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or damper positions. Graphics shall be capable of launching other web pages.
 - 3. Custom background images. Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG.
 - 4. Graphics Library. Furnish a library of standard HVAC equipment such as chillers, air handlers and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program.
 - 5. Engineering Units. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system. Unit selection shall be able to be customized by locality to select the desired units for each measurement.
- D. System Applications. Each System Controller shall provide storage of system information. Provide the following applications at each System Controller.
 - 1. Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database on the designated operator interface PC. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

2. On-Line Help and Training. Provide a context sensitive, on line help system to assist the operator in operation and editing of the system. On-line help shall be available for all system functions and shall provide the relevant data for that particular screen. Additional help shall be available through the use of hypertext links onscreen.
3. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set security levels for all other operators. Each operator password shall be able to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. All system security data shall be stored in an encrypted format.
4. System Diagnostics. The system shall automatically monitor the operation of all, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
5. Alarm Notification. Operator shall be notified of new alarm as they occur while navigating through any part of the system with an alarm icon. Alarm messages shall use full language, easily recognized descriptors for alarm. System will have the capability to acknowledge Alarms and add and save comments for the alarm.
6. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.
7. Alarm Reactions. A user shall be able to determine what actions will occur if any, upon receipt of an alarm. Actions shall display on the screen, logging, start a custom control program, displaying messages, send a SMTP e-mail message that can be directly displayed on a smart phone, or forwarded to a cell phone via a text message. Each of these actions shall be configurable by any PC and time of day.
8. Event Log. The operator shall be able to view all logged system alarms and events from any location in the system. The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in up to four categories based on severity. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be stored by the building controller. Provide a comment field in the event log that allows a user to add specific comments associated with any alarm.

9. Trend Logs. The system shall automatically create trend logs for a minimum of five key measurements for each controlled HVAC device. The automatic trend logs shall monitor these parameters for a minimum of 24 hours at 15 minute intervals. The automatic trend logs shall be user adjustable. A user shall also be able to define a trend log for any data in the system. This definition shall include interval, start-time, and stop-time. Trend intervals shall be as frequently as one minute up to yearly sampling and shall be selectable. Trend data shall be sampled and stored on the Building Controller panel and can be archived on a PC. Trend data shall be able to be viewed and printed from the operator interface software. Trends must be viewable in a text-based format or graphically. Trends shall also be storable in a CSV or PDF format for use by other industry standard word processing and spreadsheet packages.
10. Dynamic Graphical Trending. The system shall have the ability to save the data collected by a trend object and display that collected data in a graphical chart. Trend viewing capabilities shall include the ability to show up to six points on a chart, to include live and/or historical data. Each data point trend line shall be an individual color. Navigation and viewing functions shall include scrolling and zooming of x and y axes, and a trace display of the associated time stamp, and values for any selected point along the x-axis.
11. Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. These statuses shall be available by menu, on graphics or through custom programs.
12. Clock Synchronization. A designated building controller shall synchronize all other building controllers on the network. A building controller shall also be able to synchronize with a NTP server for automatic time synchronization. The system shall automatically adjust for daylight savings time if applicable.
13. Reports and Logs. Provide a reporting package that allows the operator to select reports. A number of different reports shall be available to be selected by the user and provide current data. All reports can be set up to be run at specified intervals of time. Reports and logs shall be stored on the building controller in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer. The operator shall be able to designate reports that shall be stored to disk at selectable intervals. Provide a means to list and access the last 10 reports viewed by the user.

- a) All Points in Alarm Report: Provide an on demand report showing all current alarms.
 - b) All Points in Override Report: Provide an on demand report showing all overrides in effect.
 - c) Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.
 - d) Points report: Provide a report that lists the current value of all points.
 - e) ASHRAE Standard 147 Report: Provide a daily report that shows the operating condition of each chiller as required by ASHRAE Standard 147. At minimum this report shall include:
 - (1) Chilled Water (or other fluid) inlet and outlet temperature
 - (2) Chilled Water (or other fluid) flow
 - (3) Chilled Water (or other fluid) inlet and outlet pressures
 - (4) Evaporator refrigerant pressure and temperature
 - (5) Condenser refrigerant pressure and liquid temperature
 - (6) Condenser water inlet and outlet temperatures
 - (7) Condenser water flow
 - (8) Oil pressure and temperature
 - (9) Oil level (if applicable)
 - (10) Compressor refrigerant discharge temperature
 - (11) Compressor refrigerant suction temperature
 - (12) Manual entry field for addition of refrigerant
 - (13) Manual entry field for addition of oil
 - (14) Manual entry field for vibration levels
 - (15) Motor amperes per phase
 - (16) Motor volts per phase
 - (17) Ambient temperatures (dry bulb and wet bulb)
 - (18) Date and time data logged
- E. Workstation Applications Editors. Each PC workstation shall support dedicated screens for editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at the appropriate controller panels.

1. Controller. Provide a full screen editor for each type custom application, and application specific controller that shall allow the operator to view and change the configuration, name, control parameters, and system set-points.
2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. An advance and delay time for each object shall be adjustable from this master schedule. An operator shall be able to modify the schedule. Schedules shall be able to be easily copied between objects and/or dates.
3. Manual Control and Override. Provide a means of manually controlling analog and binary output points. Control overrides shall be performed through a simple procedure. Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.
4. Air System Equipment Coordination. Provide editor screens with monitoring and control functions that group together and coordinates the operation of air handling equipment and associated VAV boxes as specified in the sequence of operations. For each air system, the editor pages shall include:
 - a) System mode of the air handling system
 - b) Listing and assignment of the associated air handler and VAV boxes
 - c) AHU supply air cooling and heating set points
 - d) AHU minimum, maximum and nominal static pressure set points
 - e) VAV box minimum and maximum flow, and drive open and close override
5. Chiller System. A chiller plant control application shall be configured using a full screen editor and shall provide operating status for the system. The display shall include:
 - a) System mode of the chiller plant
 - b) Chiller enable/disable status
 - c) System supply water setpoint
 - d) System supply and return water temperature
 - e) System chilled water pump status
 - f) System chilled water flow
 - g) Chiller or system failure information

2.05 APPLICATION AND CONTROL SOFTWARE

- A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator workstation.
- B. System Security
 - 1. User access shall be secured using individual security passwords and user names.
 - 2. Passwords shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.
 - 3. User logon/logoff attempts shall be recorded.
 - 4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
- C. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week.
 - 2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
 - 3. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
 - 4. Optimal Start. The scheduling application outlined above shall support an optimal start algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less than and greater than 24 hours. Provide the ability to modify the start algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

- D. Remote Communications. The system shall have the ability to transmit alarms to multiple associated alarm receivers. Receivers shall include PC Workstations, email addresses, and cell phones. The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself. The operator shall be able to remotely access and operate the system utilizing the system Ethernet communications, or dial up communications via modem, in the same format and method used on site as described under the Operator Interface section of this specification.
- E. PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-wind-up shall be supplied. The algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs. The controlled variable, and set-point, shall be user-selectable. The set-point shall optionally be chosen to be a reset schedule.
- F. Point control. User shall have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events.
- G. Timed Override. A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, workstation, or the operator display. The amount of time that the override takes precedence will be selectable from the workstation.
- H. Anti-Short Cycling. All binary output points shall be protected from short cycling.

2.06 SYSTEM CONTROLLERS

- A. General. Provide System Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.
 1. The System Automation System shall be composed of one or more independent, stand-alone, microprocessor based System Controllers to manage the global strategies described in System software section.
 2. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 3. The controller shall provide a USB communications port for connection to a PC.
 4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 5. Controllers that perform scheduling shall have a real time clock.
 6. Data shall be shared between networked System Controllers.
 7. The System Controller shall utilize industry recognized open standard protocols for communication to unit controllers.

8. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a) Assume a predetermined failure mode.
 - b) Generate an alarm notification.
 - c) Create a retrievable file of the state of all applicable memory locations at the time of the failure.
 - d) Automatically reset the System Controller to return to a normal operating mode.

- B. Communications. Each System Controller shall reside on the Enterprise wide network, which is same high-speed network as the workstations. The Enterprise wide network will be provided by the City and supports the Internet Protocol (IP). Local connections of the System Controller shall be on ISO 8802-3 (Ethernet). Each System Controller shall also perform routing to a network of Custom Application and Application Specific Controllers) [Optional – Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using LonTalk FTT-10 and LonMark profiles and/or use BACnet MSTP as prescribed by the BACnet standard to perform communications to a network of Custom Application and Application Specific Controllers.

- C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40 C to 50 C [-40 F to 122 F].

- D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. The System Controller shall have a display on the main board that indicates the current operating mode of the controller. All wiring connections shall be made to field removable, modular terminal connectors. The System controller shall utilize standard DIN mounting methods for installation and replacement.

- E. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller.

- F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.

2.07 CUSTOM APPLICATION CONTROLLERS

- A. General. Provide Custom Application Controllers to provide the performance specified in Section 1 of this division. Each of these panels shall meet the following requirements.

1. The Controller shall be factory mounted on the equipment where applicable.
 2. The Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 3. Controllers that perform scheduling shall have a real time clock.
 4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 5. The Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode, and generate an alarm notification.
 6. Custom application controllers shall communicate using LonTalk. Controllers shall use FTT-10 transceivers. All communications shall be with the use of LonMark-approved SNVTs.
 7. Custom application controllers shall communicate using BACnet MSTP, ANSI/ASHRAE Standard 135-2004 (BACnet).
- B. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
1. Controller used in conditioned ambient shall be mounted in IP 20 type enclosures, and shall be rated for operation at 0 C to 50 C [32 F to 120 F].
 2. Controllers used outdoors and/or in wet ambient shall be mounted within IP 56 type waterproof enclosures, and shall be rated for operation at -40 C to 70 C [-40 F to 158 F].
- C. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All low voltage wiring connections shall be made such that the controller electronics can be removed and/or replaced without disconnection of field termination wiring.
- D. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- E. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.

2.08 APPLICATION SPECIFIC CONTROLLERS

- A. General. Application specific controllers (ASC) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user programmable, but are customized for operation within the confines of the equipment they are designed to serve. The controller shall be factory mounted where applicable.

1. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
 2. Each ASC will contain sufficient I/O capacity to control the target system.
- B. Environment. The hardware shall be suitable for the anticipated ambient conditions.
1. Controller used in conditioned ambient spaces shall be mounted in IP 20 type rated enclosures. Controllers located where not to be disturbed by System activity (such as above ceiling grid), may be provided with plenum-rated enclosures and non-enclosed wiring connections for plenum cabling. All controllers shall be rated for operation at 0°C to 50°C [32°F to 120°F].
 2. Controllers used outdoors and/or in wet ambient shall be mounted within IP 56 type waterproof enclosures, and shall be rated for operation at -40°C to 65 C [-40°F to 150°F].
- C. Serviceability. Provide diagnostic LEDs for power and communications. All wiring connections shall be clearly labeled and made to be field removable.
- D. Memory. The Application Specific Controller shall maintain all BIOS and programming information in the event of a power loss for at least 90 days.
- E. Immunity to Power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.
- F. Transformer. Power supply for the ASC must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type.
- G. Application Specific Controllers shall communicate using LonTalk. Controllers shall use FTT-10 transceivers. All communications shall follow LonMark profiles. ASCs which do not have a profile that applies must comply with LonMark standards, utilize SNVTs for all listed points, and be provided with a XIF file for self-documentation.
- H. Application specific controllers shall communicate using BACnet MSTP, ANSI/ASHRAE Standard 135-2004 (BACnet).

2.09 INPUT/OUTPUT INTERFACE

- A. Hard-wired inputs and outputs may tie into the system through System, Custom, or Application Specific Controllers.
- B. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.
- C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices.

- D. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to three pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.
- E. Analog inputs shall allow the monitoring of low voltage (0-10 Vdc), current (4-20 ma), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.
- F. Binary outputs shall provide for on/off operation. Terminal unit and zone control applications may use two outputs for drive-open, drive-close (tri-state) modulating control.
- G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device.

2.10 AUXILIARY CONTROL DEVICES

- A. 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 10 CFM per square foot at 2.5" w.c. differential pressure.
 - 5. All leakage testing and pressure ratings will be based on AMCA Publication 500.
 - 6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.
- B. Control dampers shall be opposed blade types.
- C. Electric damper/valve actuators
 - 1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
 - 2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.

3. All rotary spring return actuators shall be capable of both clockwise or counter-clockwise spring return operation. Linear actuators shall spring return to the retracted position.
4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.
5. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.
6. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
7. Actuators shall be Underwriters Laboratories Standard 873 listed.
8. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

D. Control Valves

1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.
2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a) Water Valves
 - (1) Two-way: 150% of total system (pump) head.
 - (2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - b) Steam Valves: 150% of operating (inlet) pressure.
3. Water Valves:
 - a) Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - b) Sizing Criteria
 - (1) Two-position service: Line size.
 - (2) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or [5] psi, whichever is greater.
 - (3) Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), [5] psi maximum.

- (4) Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.
 - (5) 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.
 - c) Water valves shall fail normally open or closed as scheduled on plans or as follows:
 - (1) Heating coils in air handlers - normally open.
 - (2) Chilled water control valves - normally closed.
 - (3) Other applications - as scheduled or as required by sequence of operation.
 - d) Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.
4. Steam Valves:
- a) Body and trim materials shall be per manufacturer's recommendations for design conditions and service. Linear ports for modulating service.
 - b) Sizing Criteria
 - (1) Two-position service: pressure drop 10% to 20% of inlet psig.
 - (2) Modulating service 15 psig or less: pressure drop 80% of inlet psig.
 - (3) Modulating service 16 to 50 psig: pressure drop 50% of inlet psig.
 - (4) Modulating service over 50 psig: pressure drop as scheduled on plans.
- E. Binary Temperature Devices
- 1. Low-Voltage Space Thermostats shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed set point adjustment, 13°C-30°C (55°F-85°F) set point range, 1°C (2°F) maximum differential, and vented cover.
 - 2. 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, 13°C-30°C (55°F-85°F) set point range, 1°C (2°F) maximum differential, and vented cover.

3. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

F. Temperature Sensors

1. Temperature sensors shall be Resistance Temperature Device (RTD) or Thermistor.
2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 1.5m [5 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 set-point adjustment, override switch, display, and/or communication port as shown on the drawings.
5. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.1°C [0.2°F].
6. The space temperature, set point, and override confirmation will be annunciated by a digital display for each zone sensor. The set point will be selectable utilizing buttons.

G. Humidity Sensors

1. Duct and room sensors shall have a sensing range of 20% to 80% with accuracy of $\pm 5\%$ R.H.
2. Duct sensors shall be provided with a sampling chamber.
3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% R.H. It shall be suitable for ambient conditions of -40°C to 75°C [-40°F to 170°F].
4. Humidity sensor's drift shall not exceed 1% of full scale per year.

H. 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.
3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.

4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.
- I. Low limit Thermostats
1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one foot section.
 2. Low limit shall be manual reset only.
- J. Carbon Dioxide (CO₂) Sensors
1. Carbon Dioxide sensors shall measure CO₂ in PPM in a range of 0-2000 ppm. Accuracy shall be +/- 3% of reading with stability within 5% over 5 years. Sensors shall be duct or space mounted as indicated in the sequence of operation.
- K. Flow Switches
1. Flow-proving switches shall be either paddle or differential pressure type, as shown.
 2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with IP 20 Type enclosure unless otherwise specified.
 3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), IP 20 Type enclosure, with scale range and differential suitable for intended application, or as specified.
 4. Current sensing relays may be used for flow sensing or terminal devices.
- L. 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 IP 20 Type enclosure when not installed in local control panel.

M. 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 70.0 mV maximum Peak-to-Peak. Regulation shall be 5% 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.

N. Current Switches

1. 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.

O. Local Control Panels

1. All indoor control cabinets shall be fully enclosed IP 20 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.
2. Interconnections between internal and face-mounted devices shall be 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. Provide on/off power switch with over-current protection for control power sources to each local panel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the City for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the City for resolution before rough-in work is started.

3.02 PROTECTION

- A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.
- B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects

3.03 GENERAL WORKMANSHIP

- A. Install equipment, piping, wiring/conduit parallel to system 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 location as defined by Chapter 1, Article 100, Part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
- 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.

3.04 FIELD QUALITY CONTROL

- A. 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 section.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to System lines and properly supported.
- C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.05 WIRING

- A. All control and interlock wiring shall comply with the national and local electrical codes and Division 16 of these specifications. Where the requirements of this section differ with those in Division 16, the requirements of this section shall take precedence.

- B. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:
 - 1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.).
 - 2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
- C. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- D. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m [10 ft] intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 1.5 m [5 ft] intervals or more often to achieve a neat and workmanlike result.
- E. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- F. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the control system contractor shall provide step down transformers.
- G. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- H. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.
- I. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.
- J. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.
- K. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.
- L. Adhere to Division 16 requirements for installation of raceway.

- M. This contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- N. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" 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.

3.06 FIBER OPTIC CABLE SYSTEM

- A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.
- B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacturer's specifications.
- C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

3.07 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequate for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Install duct static pressure tap with tube end facing directly down-stream of air flow.
- F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
- G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.
- H. Wiring for space sensors shall be concealed in System walls. EMT conduit is acceptable within mechanical and service rooms.
- I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

3.08 FLOW SWITCH INSTALLATION

- A. Use correct paddle for pipe diameter.
- B. Install and adjust flow switch in accordance with manufacturers' instructions.
- C. Assure correct flow direction and alignment.
- D. Mount in horizontal piping - flow switch on top of the pipe.

3.09 ACTUATORS

- A. Mount and link control damper actuators per manufacturer's instructions.
 1. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 3. Valves - Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.

3.10 WARNING LABELS

- A. Affix labels on each starter and equipment automatically controlled through the DDC System. Warning label shall indicate the following:

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Affix labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects. Labels shall indicate the following:

CAUTION

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.11 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.
- 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") letters on nameplates.
- D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.12 CONTROLLERS

- A. Provide a separate Controller for each major piece of HVAC equipment. A custom application controller may control more than one system provided that all points associated with that system are assigned to the same controller. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.
- B. System Controllers and Custom Application Controllers shall be selected to provide a minimum of [15%] spare I/O point capacity for each point type found at each location. If input points are not universal, [15%] of each type is required. If outputs are not universal, [15%] of each type is required. A minimum of one spare is required for each type of point used.
 - 1. Future use of spare capacity shall require providing the field device, field wiring, points database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

3.13 CONTROL TERMINAL UNITS

- A. The 2-position steam valve serving Convectector C-1 shall be controlled by VAV box VAV-2-2.
- B. The 2-position steam valve serving Convectector C-2 shall be controlled by VAV box VAV-2-3.
- C. The 2-position steam valve serving Convectors C-3, C-4, C-5 and C-8 shall be controlled by VAV box VAV-2-4.
- D. The 2-position steam valve serving Convectector C-19a shall be controlled by VAV box VAV-2-5. The 2-position steam valve serving Convectector C-6 shall be controlled by its own wall mounted thermostat. The thermostat for C-6 shall be capable of receiving a nighttime setback from VAV-2-5.
- E. The three (3) 2-position steam valves serving Fintube FT-5, Convectors C-11 and C-12 shall be controlled by VAV box VAV-1-1.

- F. The 2-position steam valve serving Convactor C-13 shall be controlled by its own wall mounted thermostat.
- G. The 2-position steam valve serving Convactor C-14 shall be controlled by its own wall mounted thermostat.
- H. The two (2) 2-position steam valves serving Convectors C-15 and C-16 shall be controlled by VAV box VAV-1-4.
- I. The 2-position steam valve serving Convactor C-17 shall be controlled by VAV box VAV-1-6.
- J. The 2-position steam valve serving Convactor C-18 shall be controlled by its own wall mounted thermostat.
- K. The 2-position steam valve serving Convactor C-19 shall be controlled by VAV box VAV-1-5.
- L. The 2-position steam valve serving Convectors C-20, C-21 and C-7 shall be controlled by its own wall mounted thermostat. The thermostat shall be capable of receiving a nighttime setback from VAV-2-6.
- M. The 2-position steam valve serving Fintube F-4 shall be controlled by VAV box VAV-1-2. The two (2) 2-position steam valves serving Fintube F-2, F-2 and Fintube F-3 shall each be controlled by their own wall mounted thermostat. The thermostats shall be capable of receiving a nighttime setback from VAV-1-2.
- N. The 2-position steam valve serving Fintube F-5 shall be controlled by VAV box VAV-1-3.

3.14 CONTROL-RELIEF FAN

- A. Relief fan RF-1 shall be controlled by a pressure sensor in the plenum return for AHU-1. See drawings for location of sensor. When pressure sensor exceeds a preset level, RF-1 shall be energized.
- B. Relief fan RF-2 shall be controlled by a pressure sensor in the plenum return for AHU-2. See drawings for location of sensor. When pressure sensor exceeds a preset level, RF-2 shall be energized.

3.15 PROGRAMMING

- A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

C. Software Programming

1. Provide programming for the system as written in the specifications and adhere to the sequence strategies provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the control system contractor. Imbed into any custom-written control programs sufficient comment statements or inherent flow diagrams to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

D. Operators' Interface

1. Standard Graphics. Provide graphics for each major piece of equipment and floor plan in the System. This includes each Chiller, Air Handler and VAV Terminal. These standard graphics shall show all points dynamically as specified in the points list.
2. The controls contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.
3. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of [16] hours on-site. Tests shall be made in the presence of the City or City's representative.

- E. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 16 hours on-site with the City and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on-line operation.

3.16 CLEANING

- A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the construction manager or general contractor.
- B. At the completion of work in any area, the contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.

- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.17 TRAINING

- A. Provide a minimum of [2] classroom training sessions, [4] hours each, throughout the contract period for personnel designated by the City.
- B. Train the designated staff of City's representative and City to enable them to proficiently operate the system; create, modify and delete programming; add, remove and modify physical points for the system, and perform routine diagnostic and troubleshooting procedures.
- C. Additional training shall be available in courses designed to meet objectives as divided into three logical groupings; participants may attend one or more of these, depending on the level of knowledge required.
- D. Provide course outline and materials as per Part 1 of this section. The instructor(s) shall provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- F. Classroom training shall be done using a network of working controllers representative of the installed hardware or at the customer's site.
- G. This training shall be made available in addition to the interactive audio-visual tutorial, provided with the system.

3.18 ACCEPTANCE

- A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of the City. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the Completion requirements if stated as such in writing by the City's representative. Such tests shall then be performed as part of the warranty.

END OF SECTION

SECTION 15990
TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Testing, Adjusting and Balancing

1.02 SUBMITTALS

- A. Submit under provisions of Section 01010 – Summary of Work.
- B. Quality Control:
1. Qualifications and experience record of air balancing and test agency.
 2. Written verification of calibration of testing and balancing equipment.
 3. Balancing log report following completion of system adjustments including test results, adjustments and rebalancing procedures.

1.03 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 – Contract Closeout.

1.04 QUALITY ASSURANCE

- A. Air Balancing and Test Agency Qualifications.
1. Corporately and financially independent organization functioning as an unbiased testing authority.
 2. Professionally independent of manufacturers, suppliers and installers of HVAC equipment being tested.
 3. Certified by a national balancing association.
 4. Have a proven record of at least five similar projects.
 5. Employer of engineers and technician regularly engaged in testing and inspecting HVAC equipment and systems.

1.05 GUARANTEE

- A. Comply with provisions of Section 01010 – Summary of Work.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with work in accordance with Section 01710.

3.02 GENERAL

- A. Calibrate test instruments to a recognized standard before beginning the Work.
- B. Adjust and balance air systems in accordance with standard procedures and recognized practices of the Associated Air Balance Council or SMACNA HVAC Testing, Adjusting and Balancing Manual.

3.03 ADJUSTING AND BALANCING AIRSIDE

- A. Measure fan system performance in accordance with AMCA 203.
- B. Adjust air volumes on supply diffusers, supply registers and return grilles to the quantity shown on the plans. Allowable variation from quantity shown on plans shall be plus 10 percent and minus 0 percent.
- C. Adjust air volumes on exhaust grilles to the quantity shown on the plans. Allowable variation from quantity shown on plans shall be plus 10 percent and minus 0 percent.
- D. In each system, a minimum of one (1) air path from fan to final branch duct termination shall have all dampers fully open. Achieve final air quantities by adjusting fan speed.
- E. Adjust Fan Air Volumes
 1. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variations of plus 10/minus 0 percent.
 2. After final adjustments, do not operate motor above nameplate amperage on any phase.
 3. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust and full return air.
 4. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Provide written notice to the equipment manufacturer and the City if drive or belt changes were made.
- F. Adjust outside air dampers, return air dampers, exhaust air dampers and motorized louvers for maximum and minimum air requirements.
- G. Adjust diffusers and grilles for proper deflection, throw and coverage. Eliminate drafts and noise where possible.

3.04 FIELD QUALITY CONTROL

- A. Perform functional tests as required by Section 01650, STARTING OF SYSTEMS.

B. Balancing Log Report Requirements

1. Log and record information from every test, reading and adjustment necessary to accomplish the services described.
 - a) Equipment identification number.
 - b) Equipment nameplate data (manufacturer, model, size, type and serial number).
 - c) Motor data (frame, hp, FLA and rpm).
 - d) Sheave and belt size.
 - e) Starter and heater data.
2. Include a reduced set of HVAC drawings in the balance log showing the final air and waterflow readings for each system.
3. Indicate the recorded site values and velocity and mass correction factors used to provide equivalent standard air quantities.

END OF SECTION

SECTION 16010**BASIC ELECTRICAL REQUIREMENTS****PART 1 - GENERAL****1.1 RELATED SECTION**

- A. Requirements specified within this section apply to all sections and shall be performed as if specified in the individual sections.

1.2 SCOPE OF WORK

- A. The Contractor shall be responsible for disconnecting, removing, and disposing of all HVAC equipment being demolished where shown on the contract drawings and all associated power and control wiring; all power and control wiring shall be removed from the equipment back to the source. The contractor shall also disconnect, remove and dispose of lighting fixtures and all connected wiring and conduit in areas where the existing ceiling is being demolished; however, lighting fixtures and controls shall not be removed in areas where the old ceiling is going to remain in place. In areas where there is an existing ceiling grid that is going to remain, the Contractor may remove and replace lighting fixtures to facilitate HVAC work, as necessary.
- B. The Contractor shall provide temporary lighting to all work spaces that require continued occupancy during construction. Temporary lighting shall be provided to recommended IES levels according to the type of room activity.
- C. The Contractor shall furnish and install all electrical wire, cable, and conduit necessary to provide electrical power, signaling and control for all fire alarm, HVAC, and steam heating equipment, valves, sensors, and other appurtenances in order to provide a complete and operational HVAC system as intended by these contract documents and as shown on the contract drawings.
- D. This work shall include the furnishing and installation of new power panels, circuit breakers, disconnects and motor starters as indicated on the contract drawings to feed the new HVAC equipment. Note that the Contractor shall furnish and install new circuit breakers in the existing Distribution Centers 6 and 7 to protect new power panel and HVAC equipment feeders; these circuit breakers are special order and must be retrofit into the existing Kinney panels.

- E. The Contractor shall perform all equipment programming and shall furnish and install all I/O, wiring, and interlocks, needed to provide the City with the fully functional HVAC system described in the specifications and drawings. The Contractor shall also furnish and install network and communication cabling from the City's Ethernet switch to the host PC workstation, network cabling to the HVAC controllers, fire alarm system cabling and communications and control cabling between the fire alarm system and the HVAC control system.
- F. All new lighting fixtures complete with lamps and ballasts, power packs, sensors, and controls as shown on the contract drawings, shall be furnished and installed by the Contractor.
- G. The Contractor shall furnish Operation and Maintenance Manuals as required in Summary of Work, Section 01010, along with as-built drawings which reflect all field changes to the original drawings. The Contractor shall include on the electrical as-built plans, all electrical and network device locations that have been established in the field which may have not been shown on the original drawing.
- H. Test all circuits for continuity and proper operation.
- I. Test all setpoints and programming of all loops and sequences for proper operation.

1.3 CODES AND PERMITS

- A. All work shall be performed and materials furnished in accordance with the National Electric Code (NEC), National Electrical Safety Code (NESC), and the following standards where applicable:

ANSI -	American National Standard Institute
ASTM -	American Society for Testing and Materials
Fed Spec -	Federal Specifications
ICEA -	Insulated Cable Engineers Association
IEEE -	Institute of Electrical and Electronic Engineers
IES -	Illuminating Engineering Society
NEMA -	National Electric Manufacturers Association
NFPA -	National Fire Protection Association
UL -	Underwriters' Laboratories

PART 2 – PRODUCTS

2.1 GENERAL

- A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

2.2 CABLE

- A. Instrument cable for electric circuits to instrumentation, metering and other signaling and control equipment shall be two or three conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield.
- B. When required, cable for circuits rated 2400 volts and over, and for wet or dry conditions & locations in conduit and open air, shall be 5kV-power cable.
- C. Cable in power, control, indication, and alarm circuits operating at 600 volts or less, except where lighting, multiconductor control and instrument cables are permitted or required, shall be 600 volt power cable.

PART 3 EXECUTION

3.1 GENERAL

- A. Electrical drawings show general locations of equipment, devices and raceways, unless specifically dimensioned. Contractor shall examine areas and surfaces prior to mounting equipment to ensure compliance with all governing code and manufacturer's requirements, installation tolerances, and other conditions affecting performance. Installation of equipment shall proceed only after unsatisfactory conditions have been corrected.
- B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.2 LOAD BALANCE

- A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.
- B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.
- C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate records of changes made, and provide circuit directory that lists final circuit arrangement.

3.3 CHECKOUT AND START-UP

Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

END OF SECTION

SECTION 16100**FUSES****PART 1 GENERAL****1.01 GENERAL CONDITIONS**

This section covers disconnect fuses where required and as shown on the drawings and described herein.

1.02 SCOPE

The contractor shall furnish and install a complete set of fuses for each fusible switch and disconnect switch. Fuses shall have a voltage rating not less than the circuit voltage. The contractor shall provide and install all fuses and circuit breakers where indicated on the contract drawings, pursuant to the circuit and load characteristics.

1.03 RELATED WORK

Drawings, other sections of these specifications, and general provisions of the contract, apply to this section.

1.04 SUBMITTALS

For each fuse provided under this contract, submit manufacturer's name, catalog data, and the following information:

Shop drawings for each disconnect switch shall include the following:

1. Catalog data
2. Time-Current Curves
3. Current Limitation Curves.
4. Short Circuit/Selective Coordination Study

PART 2 PRODUCTS**2.01 MANUFACTURERS**

Products shall be as manufactured by one of the following:

1. Cooper Bussman
2. Approved other.

2.02 ENCLOSURE

Provide NEMA Type 1 disconnect switches in dry interior locations and NEMA Type 4 in wet or damp locations unless otherwise noted. NEMA 3R is acceptable for exterior locations is installed per manufacturer's recommendations.

2.03 MAINS, FEEDERS, AND BRANCH CIRCUITS

Circuits 601 to 6000 amperes shall be protected by UL Class L current limiting Bussmann LOW-PEAK Time-Delay fuses type KRP-CSP. Fuses shall hold 500% rated current for a minimum of four seconds, clear 20 times rated current in 0.01 seconds or less, and have an interrupting rating of 200,000 amperes RMS symmetrical.

Circuits 0-600 amperes shall be protected by Time-Delay UL Class RK1 or UL Class J current-limiting Bussmann LOW-PEAK dual-element fuse type LPN-RKSP/LPS-RKSP, or LP-SP. The dual-element fuses shall have separate overload and short-circuit elements. Fuses shall hold 500% of rated current for a minimum of ten seconds (30A, 250V Class RK1 case shall be a minimum of eight seconds), and have an interrupting rating of 2000,000 amperes RMS symmetrical.

1. Paint color shall be ANSI 61TGIC polyester powder, applied electrostatically through air and baked to produce a hard, durable finish.
2. The enclosure shall be brush finished on type 304 stainless steel for Type 4 stainless steel.
3. The enclosure shall have ON and OFF stamped onto the cover.
4. The operating handle shall be provided with a dual colored, red/black position indication.
5. All switches shall have provisions to accept up to three 3/8 in. hasp pad locks to lock the operating handle in the OFF position.

2.06 SWITCH RATINGS

Switches shall be horsepower rated for AC and/or DC as indicated on the plan and as determined by the branch circuit and load characteristics.

The UL listed short circuit current rating of the switches shall be:

1. 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes).
2. 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

PART 3 EXECUTION

3.01 INSTALLATION

Final tests and inspections shall be made prior to energizing equipment. These tests shall include thorough cleaning, tightening, and review of the electrical connections and inspection of the grounding conductors. The contractor shall also verify that the voltage rating of the fuse is not less than the circuit voltage.

“LOW-PEAK YELLOW” notice labels shall be field installed by the contractor to identify the engineered level of protection. They shall be marked with the proper fuse rating and placed in a conspicuous location on the enclosure.

Upon final acceptance of the project, the contractor shall furnish the City with three of each type and rating of installed fuse as spares.

END OF SECTION

SECTION 16111**CONDUIT****PART 1 GENERAL**

Applicable provisions of Division 1 shall govern all work under this Section.

1.01 SCOPE

Raceways shall be installed as a complete system continuous from service to outlet or equipment, mechanically and electrically connected, constituting a continuous ground system.

1.02 RELATED WORK

Section 16190 - Supporting Devices.

PART 2 PRODUCTS**2.01 INTERMEDIATE METAL CONDUIT AND FITTINGS**

Conduit: Thick-wall, steel, hot-dip galvanized O.D. with organic corrosion resistant I.D. coating, threaded.

Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

2.02 FLEXIBLE METAL CONDUIT AND FITTINGS

Conduit: steel, galvanized, spiral strip.

Fittings and Conduit Bodies: All steel, galvanized, or malleable iron.

2.03 LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.

Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

2.04 CONDUIT SUPPORTS

See section 16190.

2.05 GENERAL

All steel fittings and conduit bodies shall be galvanized.

No cast metal, split or gland type fittings permitted.

Condulets larger than 2 inch (50 mm) not permitted except as approved or detailed.

All conduit covers must be fastened to the conduit body with screws and be of the same manufacture.

Wireways and gutters shall not be used in lieu of pull boxes and condulets.

PART 3 EXECUTION

3.01 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (13 mm) minimum except as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**

Size conduit for all other wiring, including but not limited to data, control, signal, etc. shall be sized per number of conductors pulled and their cross-section. A maximum of 40% fill shall be used for all new conduit fills.

Arrange conduit to maintain headroom and present a neat appearance.

Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.

Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.

Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.

Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, etc., unless so approved or detailed.

Contractor shall verify with Engineer all surface conduit installations.

Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.

No continuous conduit run shall exceed 100 feet (30 meters) without a junction box.

3.02 CONDUIT INSTALLATION

Cut conduit square using a saw or pipecutter; de-burr cut ends.

Bring conduit to the shoulder of fittings and couplings and fasten securely.

Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations (sheet metal boxes 4 & 11/16th" square and larger, shall contain NO pre-punched or concentric knockouts).

All conduit terminations (except for terminations into conduit bodies) shall use connectors or conduit hubs with one locknut or shall use double locknuts (one each side of box wall) and insulating bushing. Provide bushings for the ends of all conduits not terminated in box walls.

Install no more than the equivalent of three 90 degree bends between boxes.

Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.

Conduit shall be bent according to manufacturer's recommendations.

Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.

Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.

Install expansion-deflection joints where conduit crosses building expansion joints. Note: expansion-deflection joints are not required where conduit crosses building control joints if the control joint does not act as an expansion joint.

Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.

Identify conduit under provisions of Section 16195.

END OF SECTION

SECTION 16123**WIRE AND CABLE**
(Below 600 Volts)**PART 1 GENERAL**

Applicable provisions of Division 1 shall apply to all work under this Section.

1.01 SCOPE

Furnishing and installing required wiring and cabling systems including pulling, terminating, and splicing.

1.02 RELATED WORK

Section 16111 - Conduit
Section 16130 - Boxes
Section 16195 - Identification

1.03 REFERENCES

NFPA 70 - National Electrical Code

1.04 SUBMITTALS

Submit under provisions of General Conditions of the Contract and Section 16010.

Submit product data: Provide for each cable assembly type.

Submit factory test reports: Indicate procedures and values obtained.

Submit shop drawings for modular wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.

Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.05 PROJECT CONDITIONS

Verify that field measurements are as shown on Drawings.

Conductor sizes are based on copper.

Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.06 REGULATORY REQUIREMENTS

Conform to requirements of ANSI/NFPA 70.

Furnish products listed and classified by Underwriters' Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.07 COORDINATION

Coordinate Work under provisions of Division 1.

Determine required separation between cable and other work.

Determine cable routing to avoid interference with other work.

PART 2 PRODUCTS

2.01 GENERAL

Verify that field measurements are as shown on drawings; route wire and cable as required to meet Project Conditions.

Where wire and cable routing is not shown and destination only is indicated, determine exact routing lengths required.

All conductor sizes are based on copper.

Aluminum conductors shall not be used.

All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.

Computer and control cable shall be plenum-rated.

2.02 BUILDING WIRE AND CABLE

Description: Single conductor insulated wire.

Conductor: Copper.

Insulation Rating: 600 volts, 75°C.

Insulation: ANSI/NFPA 70; Type THHN/THWN, XHHN insulation for feeders and branch circuits.

2.03 REMOTE CONTROL AND SIGNAL CABLE

All other systems cabling shall meet the requirements of NEC Article 725 and the following:

Control Cable for Class 1 Remote Control and Signal Circuits: 600 volt insulation, individual conductors twisted together, and covered with an overall PVC jacket. All analog signal cable shall also be shielded. Cable shall be UL listed, temperature rated, and plenum rated for this application as required in the National Electrical Code.

Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits shall be constructed, UL listed, temperature rated, and plenum rated for this application as required in the NEC Article 725.

2.04 WIRING CONNECTORS

1. Split Bolt Connectors.
2. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.
3. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
4. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.
5. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.

PART 3 EXECUTION

3.01 INSTALLATION

All wire and cable shall be installed in conduit. However, plenum-rated, low voltage control and signal cables may be installed without conduit above accessible ceilings if the cable meets NEC requirements for the application unless specified to be in conduit in other sections of the specifications.

Install products in accordance with manufacturer's instructions.

Use solid conductor for feeders and branch circuits 10AWG and smaller.

Use conductor not smaller than 12 AWG for power and lighting.

Use conductor not smaller than 14 AWG for control wiring greater than 60 volts, or 16 AWG for voltages less than 60 volts, all sizes subject to NEC 725 requirements.

Use 10AWG conductors for 20 A., 120 volt branch circuits longer than 75 feet unless specified otherwise.

Use 10AWG conductors for 20 A., 277 volt branch circuits longer than 200 feet unless specified otherwise.

All conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity.

Pull all conductors into raceway at the same time.

Use suitable wire-pulling lubricant for building wire 4AWG and larger.

Protect exposed cable from damage.

Support cables above accessible ceiling, using spring metal clips or metal or plastic cable ties to support cables from structure.

Use suitable cable fittings and connectors.

Neatly train and lace wiring inside boxes, equipment, and panelboards.

Clean conductor surfaces before installing lugs and connectors.

Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

Make conductor lengths for parallel conductors equal.

Splice only in junction or outlet boxes.

Identify ALL low voltage, 600v and lower, wire per section 16195.

3.02 WIRING INSTALLATION IN RACEWAYS

Pull all conductors into a raceway at the same time. Use Listed wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary.

Install wire in raceway, after interior of building has been physically protected from the weather and all mechanical work likely to damage conductors, has been completed.

Completely and thoroughly swab raceway system before installing conductors.

Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an equal number of phase and neutral conductors in same raceway or cable. Other areas shall use insulation rated 75 degrees C unless stated otherwise in other parts of these specifications and drawings.

All conductors must be suitable for the application intended. Conductors #10 and larger must be stranded. Conductors #12 and smaller may be solid or stranded with the following requirements or exceptions:

All conductors terminated with crimp type devices must be stranded.

Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.

3.03 WIRING CONNECTIONS AND TERMINATIONS

Splice only in accessible junction boxes.

Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.

All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.

Use solderless spring type pressure connectors with insulating covers for wire splices and taps, 10 AWG and smaller.

Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger.

Tape uninsulated conductors and connectors with electrical tape up to 150 percent of the insulation value of conductor.

Thoroughly clean wires before installing lugs and connectors.

At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

3.04 FIELD QUALITY CONTROL

Field inspection and testing will be performed under provisions of Section 16010.

3.05 WIRE COLOR

A. General:

Wire sizes 10 AWG and smaller - Wire shall be colored as indicated below.

Wire sizes 8 AWG and larger - Identify wire with colored tape at all terminals, splices and boxes; colors to be as indicated below.

In existing facilities, use existing color scheme.

In new facilities, use black and red for single phase circuits at 120/240 volts, use Phase A black, Phase B red and Phase C blue for circuits at 120/208 volts single or three phase, and use Phase A brown, Phase B orange and Phase C yellow for circuits at 277/480 volts single or three phase. Note: This includes fixture whips except for Listed whips mounted by the fixture manufacturer on the fixture and Listed as a System.

B. Neutral Conductors:

White for 120/208V and 120/240V systems; gray for 277/480V systems. Where there are two or more neutrals in one conduit, each shall be individually identified with the proper circuit.

C. Branch Circuit Conductors:

Three or four wire home runs shall have each phase uniquely color coded.

D. Feeder Circuit Conductors:

Each phase shall be uniquely color coded.

E. Grounded Conductors:

Green for 6 AWG and smaller; for 4 AWG and larger, identify with green tape at both ends and at all access points, such as panelboards, motor starters, disconnects and junction boxes. When isolated grounds are required, contractor shall provide green with yellow tracer.

3.06 BRANCH CIRCUITS

Circuits shall not share a neutral; each circuit shall be run with its own individual neutral.

The use of multi-wire branch circuits with a common neutral feeding load is not permitted.

All branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductor.

END OF SECTION

SECTION 16130

BOXES

PART 1 GENERAL

Applicable provisions of Division 1 shall apply to all work under this Section.

1.01 SCOPE

Pull and junction boxes for power, low voltage, and fiber optic installations.

1.02 SUBMITTALS

Submit product data under provisions of Division 1 and Section 16010.

Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 - PRODUCTS

2.01 GENERAL

All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

2.02 PULL AND JUNCTION BOXES

Pull boxes and junction boxes shall be minimum 4 inch square (100 mm) by 2 1/8th inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit or larger, pull and junction boxes shall be sized per NEC but not less than 4 11/16 inch square (117 mm).

For fiber optic and other low voltage cable installations the NEC box size requirements shall apply. All boxes, used on low voltage and fiber optic systems with conduits of 1 1/4" and larger, shall be sized per the NEC conduit requirements. For determining box size, the conduit is the determining factor not the wire size.

Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

Sheet Metal Boxes Larger than 12 Inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover.

Cast Metal Boxes for Outdoor and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron or aluminum box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

Box extensions and adjacent boxes within 48" of each other are not allowed for the purpose of creating more wire capacity.

Junction boxes 6" x 6" or larger size shall be without stamped knock-outs.

Wireways shall not be used in lieu of junction boxes.

PART 3 EXECUTION

3.01 COORDINATION OF BOX LOCATIONS

Provide electrical boxes as required for splices, taps, wire pulling, equipment connections, and code compliance.

Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors.

Locate and install to maintain headroom and to present a neat appearance.

Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

3.02 PULL AND JUNCTION BOX INSTALLATION

Support pull and junction boxes independent of conduit.

END OF SECTION

SECTION 16190
SUPPORTING DEVICES

PART 1 GENERAL

Applicable provisions of Division 1 shall apply to all work under this Section.

1.01 SCOPE

The work under this section includes conduit and equipment supports, straps, clamps, steel channel, etc. and fastening hardware for supporting electrical work.

1.02 SUBMITTALS

Submit data for support channel under provisions of Division 1 and Section 16010.

PART 2 PRODUCTS

2.01 MATERIAL

Support Channel: Steel, galvanized, enameled or other corrosion resistant approved equal.

Hardware: Corrosion resistant.

Minimum size threaded rod for supports shall be 3/8" for trapezes and single conduits 1-1/4" and larger, and 1/4" for single conduits 1" and smaller.

Conduit clamps, straps, supports, etc., shall be steel or malleable iron. One-hole straps shall be heavy duty type. All straps shall have steel or malleable iron backing plates when rigid steel conduit is installed on interior or exterior surface of any exterior building wall.

PART 3 EXECUTION

3.01 INSTALLATION

Fasten hanger rods, conduit clamps, outlet, junction & pull boxes to building structure using pre-cast insert system, preset inserts, beam clamps, or expansion anchors.

Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors on concrete surfaces; sheet metal screw in sheet metal studs and wood screws in sheet metal studs and wood screws in wood construction. If nail-in anchors are used, they must be removable.

Power-actuated fasteners and plastic wall anchors are not permitted.

File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting.

Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.

Lighting fixtures and conduit shall be supported independently of the ceiling grid.

Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to present a neat and workmanlike appearance. Use hexagon head bolts with spring locks under all nuts.

In wet locations, mechanical and electrical rooms, install free-standing electrical equipment on 3-1/2" concrete pads unless specified otherwise.

Install surface-mounted cabinets and panelboards with a minimum of four anchors. Provide steel channel supports to stand cabinet one inch off wall.

Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

Furnish and install all supports as required to fasten all electrical components required for the project, including free-standing supports required for those items remotely mounted from the building structure, catwalks, walkways, etc.

END OF SECTION

SECTION 16195**ELECTRICAL IDENTIFICATION****PART 1 GENERAL**

Applicable provisions of Division 1 shall apply to all work under this Section.

1.01 SCOPE

This section describes the products and execution requirements relating to labeling of power, lighting, general wiring, and signal wire and cabling. Further, this section includes labeling of all terminations and related sub-systems, including but not limited to nameplates, stenciling, wire and cable marker labeling of all equipment and labeling of inner duct (fiber optic).

1.02 RELATED WORK

Section 16123 - Building Wire and Cable (Below 600 Volts)

1.03 SUBMITTALS

Submit shop drawings under provisions of Division 1, General Conditions of the Contract, and Section 16010.

Include schedule for nameplates and stenciling.

Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8 1/2" x 11" sheets annotated, explaining their proposed use.

PART 2 PRODUCT**2.01 MATERIALS**

Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED.

Label size shall be appropriate for the conductor or cable size(s). All labels shall be self-laminating, white/transparent vinyl and be wrapped around the cable or sheath. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the

circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.

Nameplates: Engraved three-layer laminated plastic, black letters on a white background. Emergency system shall use white letters on red background.

Tape (phase identification only): Scotch #35 tapes in appropriate colors for system voltage and phase.

Adhesive type labels not permitted except for phase and wire identification.

PART 3 EXECUTION

3.01 GENERAL

Where mixed voltages are used in one building (e.g. 4160 volt, 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system must be labeled for voltage in addition to other requirements listed herein.

All branch circuit and power panels must be identified with the same symbol used in circuit directory in main distribution center.

Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent.

Install all labels firmly as recommended by the label manufacturer.

Labels shall be installed plumb and neatly on all equipment.

Install nameplates parallel to equipment lines.

Secure nameplates to equipment fronts using screws, or rivets. Secure nameplate to inside of recessed panelboards in finished locations.

Embossed tape will not be permitted for any application.

3.02 JUNCTION AND PULLBOX IDENTIFICATION

The following junction and pullboxes shall be identified utilizing spray painted covers:

<u>System</u>	<u>Color(s)</u>
Secondary Power – 480Y/277V	Brown
Secondary Power – 208Y/120V, 240/120V	White

3.03 INNERDUCT LABELING

All innerduct containing fiber optic cable installed under this project shall be labeled where exposed.

The innerduct shall be labeled with a durable Yellow Polyethylene tag which reads "CAUTION FIBER OPTIC CABLE" and includes blank spaces for adding fiber count and destination information. The destination of the cable(s) contained in the innerduct and the fiber count shall be marked on the tag. Hand lettering is acceptable on this tag, using an indelible type ink.

The tag shall be secured to the innerduct(s) using self-locking ties.

Innerduct shall be labeled on each floor in a riser installation, in each manhole and/or handhole or at 25-foot intervals in a tunnel or tray installation.

3.04 POWER AND CONTROL WIRE IDENTIFICATION

Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

All wiring shall be labeled within 2 to 4 inches of terminations. Each end of a wire or cable shall be labeled as soon as it is terminated including wiring used for temporary purposes.

3.05 NAMEPLATE ENGRAVING

Provide nameplates of minimum letter height as scheduled below.

Panelboards, Switchboards and Motor Control Centers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify voltage rating, source and room location of the source.

Equipment Enclosures: 1 inch (25 mm); identify equipment designation.

Circuit Breakers, Switches, and Motor Starters in Panelboards or Switchboards or Motor Control Centers: 1/2 inch (13 mm); identify circuit and load served, including location.

Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: 1/2 inch (13 mm); identify source and load served.

Transformers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify primary and secondary voltages, primary source, and secondary load and location.

Junction boxes: 1 inch (25 mm); identify system source(s) and load(s) served. Junction boxes may be neatly identified using a permanent marker.

3.06 PANELBOARD DIRECTORIES

Typed directories for panels must be covered with clear plastic, have a metal frame. Room number on directories shall be City's numbers, not Plan numbers unless City so specifies.

END OF SECTION

SECTION 16410**DISCONNECT SWITCHES AND CIRCUIT BREAKERS****PART 1 GENERAL****1.01 DESCRIPTION OF WORK**

This section covers disconnect switches where required and as shown on the drawings and described herein.

1.01 SCOPE

The contractor shall furnish and install all disconnect switches where shown on the contract drawings and detailed in the specifications. The contractor shall provide and install all fuses and circuit breakers where indicated on the contract drawings suited to the circuit and load characteristics.

The contractor shall furnish and install all enclosed molded-case circuit breakers where required by the contract drawings unless specified otherwise. New circuit breakers required in existing and new lighting and power panels, and Distribution Center 6 and Distribution Center 7, shall be furnished and installed by City forces.

1.02 RELATED WORK

Drawings, other sections of these specifications, and general provisions of the contract, apply to this Section.

1.03 SUBMITTALS

For each disconnect switch provided under this contract, submit manufacturer's name, catalog data, and the following information:

Shop drawings for each disconnect switch shall include the following:

1. Terminal connection sizes.
2. Cabinet dimensions.
3. Finish data.
4. Voltage rating.
5. Manufacturer, types, equipment rating for voltage, horsepower, amperage, and fault current.

Closeout submittals shall operation and maintenance data, including nameplate data, parts lists, fuse manufacturer's time current coordination curves, factory and field test reports and recommended maintenance procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Products shall be as manufactured by one of the following:

1. Square D.
2. Siemens.
3. Approved other.

2.02 ENCLOSURE

Provide NEMA Type 1 disconnect switches in dry interior locations and NEMA Type 4 in wet or damp locations unless otherwise noted. NEMA 3R is acceptable for exterior locations is installed per manufacturer's recommendations.

2.03 FEATURES

The switch interior shall include the following features:

1. All switches shall have switch blades which are visible when the switch is OFF and the cover is open.
2. Lugs shall be front removable and UL Listed for 75degrees C conductors, aluminum or copper conductors for Type 1 and 3R, and copper conductors only for Type 4.
3. 30 through 100 ampere switches shall be equipped with field installed fuse pullers for Type 1 or Type 3R and factory installed for Type 4.
4. Switches required for Type 4 stainless steel applications shall have all copper current carrying parts.
5. All current carrying parts shall be plated to resist corrosion.
6. Switches shall have removable arc suppressors to facilitate easy access to line side lugs.
7. Switches shall have provisions for a field installable electrical interlock.

2.04 SWITCH MECHANISM

The switch mechanism shall include the following features:

1. Switch mechanism shall be quick make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started.
2. The operating handle shall be an integral part of the box, not the cover.
3. Provisions for padlocking the switch in the OFF position with at least three padlocks shall be provided.
4. The handle position shall travel at least 90 degrees between ON and OFF positions to clearly distinguish and indicate handle position.
5. All switches shall have a dual cover interlock mechanism to prevent unintentional opening of the cover when the switch is ON and to prevent turning the switch ON when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure on order to override the interlock.

2.05 SWITCH ENCLOSURES

Switch enclosures shall include the following features:

1. All switch covers shall be attached with welded pin-type hinges for Type 1 or 4 stainless steel, and top-hinged, attached with removable screws and securable in the open position for Type 3R.
2. All non-plated steel parts shall be zinc plated.
3. All painted steel parts shall be cleaned and a zinc phosphate (outdoor equipment) or iron phosphate (indoor equipment) pre-treatment applied prior to paint application.
4. Paint color shall be ANSI 61TGIC polyester powder, applied electrostatically through air and baked to produce a hard, durable finish.
5. The enclosure shall be brush finished on Type 304 stainless steel for Type 4 stainless steel.
6. The enclosure shall have ON and OFF stamped onto the cover.
7. The operating handle shall be provided with a dual colored, red/black position indication.
8. All switches shall have provisions to accept up to three 3/8 in. hasp pad locks to lock the operating handle in the OFF position.

2.06 SWITCH RATINGS

Switches shall be horsepower rated for AC and/or DC as indicated on the plan and as determined by the branch circuit and load characteristics.

The UL listed short circuit current rating of the switches shall be:

1. 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (0-600 ampere switches employing appropriate fuse rejection schemes).
2. 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

2.07 ENCLOSED CIRCUIT BREAKERS

Enclosed Molded-Case Circuit Breaker: NEMA AB 1, lockable handle with two padlocks.

Characteristics: Inverse time-current characteristic for overload and instantaneous magnetic trip element for short circuit interruption; UL 489 tested and approved. Adjustable magnetic trip settings for circuit breaker frame sizes over 250A. Frame size, trip rating, number of poles and auxiliary devices as indicated on the contract drawings; interrupting rating to meet available fault current.

Lugs: Mechanical lugs and power distribution connectors for number, size, and material of conductors indicated.

PART 3 – EXECUTION

3.01 INSTALLATION

Install enclosed switches and circuit breakers where indicated on the contract drawings and in accordance with the manufacturer's instructions.

Comply with all mounting and anchoring requirements; install switches level and plumb, so that operating handle shall not be higher than 72 inches above the floor.

Install wiring between enclosed switches and circuit breakers and control/indication devices.

Connect enclosed switches and circuit breakers and components to wiring system and to ground as instructed by the manufacturer and in compliance with all governing codes. Tighten connectors and terminal, including screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to tightening torques specified in UL Standard 486A.

3.02 TESTING

After installing enclosed switches and circuit breakers and when electrical power is applied, demonstrate product capability and compliance with requirements.

Perform visual and mechanical inspections and electrical tests in accordance with NETA Standard ATS, Section 7.5 for enclosed switches and Section 7.6 for molded-case breakers. Certify compliance with test parameters.

Malfunctioning units shall be corrected at site, if feasible, and retested to demonstrate compliance; otherwise defective units shall be removed and replaced with new.

3.02 ADJUSTING

Set field-adjustable enclosed switches and circuit breaker trip ranges to conform to indicated ratings and settings. Make final adjustments and settings. Coordinate with Project Engineer.

END OF SECTION

SECTION 16420
ENCLOSED CONTROLLERS

PART 1 – GENERAL

This section covers AC, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.

1.01 SCOPE

The contractor shall furnish and install all enclosed controllers where in the contract drawings and specifications. The contractor shall provide all base supports and other mounting accessories necessary to complete the installation as further described herein.

1.02 RELATED WORK

Drawings, other sections of these specifications, and general provisions of the contract, apply to this section.

1.03 SUBMITTALS

For each type of enclosed controller, provide dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

Shop drawings for each enclosed controller shall include the following:

1. Tabulations of installed devices, equipment features, and ratings.
2. Each installed unit's type and details.
3. Short-circuit rating of integrated unit.
4. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NTRL acceptable to authorities having jurisdiction.
5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
6. Power, signal, and control wiring diagrams.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

Products shall be as manufactured by one of the following:

1. Square D
2. Eaton Corporation; Cutler-Hammer Products
3. Approved other

2.02 ACROSS-THE-LINE ENCLOSED CONTROLLERS

MANUAL MOTOR CONTROLLERS: Manual controller shall be NEMA ICS 2, general purpose, Class A, with “quick- make, quick-break” toggle or pushbutton action and marked to indicate whether unit is “OFF”, “ON”, or “TRIPPED”. Manual controllers shall include ambient-compensated type overload relay with inverse-time – current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they are connected and shall have appropriate adjustment for duty cycle.

MAGNETIC CONTROLLERS: Magnetic controller shall be NEMA ICS 2, Class A, full voltage, non-reversing, across-the-line, size as required by load. Manual controllers shall include ambient-compensated type overload relay with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they are connected and shall have appropriate adjustment for duty cycle.

Controller shall include control circuit transformer shall be provided with secondary voltage as shown on the contract drawings, primary and secondary fusing, minimum 75 VA or of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 per cent spare capacity.

Adjustable overload relay shall be provided, with dip switch selection for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor and current unbalance and single phasing. Provide relay with Class II ground fault protection, with start and run delays to prevent nuisance trip on starting.

COMBINATION MAGNETIC CONTROLLER: Combine factory-assembled combination controller and disconnect switch where indicated. Fusible disconnecting means shall be NEMA KS 1, heavy-duty, fusible switch with rejection- type fuse clips rated for fuses. Fuses shall be sized to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL. Non-fusible disconnecting means shall be NEMA KS 1, heavy-duty, non-fusible switch. Where circuit-breaker disconnecting means are called for, NEMA AB 1, motor-circuit protector shall be provided with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.03 ENCLOSURES

Contractor shall provide surface-mounted cabinets where indicated, unless otherwise noted. Enclosures shall be NEMA 250, Type 1 unless otherwise indicated to comply with environmental conditions at installed location. Enclosures in wet or damp indoor locations shall be NEMA 250, Type 4.

PART 3 – EXECUTION

3.01 EXAMINATION

Contractor shall examine areas and surfaces to receive enclosed controllers for compliance with re-quirements, installation tolerances, and other factors affecting performance, and shall proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

Contractor shall select horsepower rating and other features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor, required control sequence as determined by HVAC system operation, motor duty cycle, controller and load, and configuration of pilot device and control circuit affecting controller functions.

3.03 INSTALLATION

Wall-mounted controller units may be directly bolted to wall or if necessary may be mounted on lightweight structural steel channels bolted to wall; freestanding controllers shall be installed on concrete bases.

Comply with all mounting and anchoring requirements, install enclosed controllers plumb at a height of 5 ft. from floor to operating handle.

Install fuses in each fusible switch and select and install solid state electronic overload elements in motor controllers to match installed motor characteristics.

Set field-adjustable switches and circuit breaker trip ranges.

Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit. Test continuity of each circuit.

Provide engraved nameplates. Neatly type label and place inside each motor controller door identifying motor service, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.04 CONTROL WIRING INSTALLATION

Install wiring for enclosed controllers. Connect hand-off-auto switch and other control devices where applicable. Test and verify control device function, control sequences, and motor operation.

END OF SECTION

SECTION 16471**PANELBOARDS****PART 1 – GENERAL**

1.01 This section includes design and performance requirements for the following:

1. Service-entrance panelboards
2. Power distribution panelboards
3. Lighting and appliance panelboards
4. Multi-section panelboards

1.02 SCOPE

The contractor shall furnish and install all enclosed controllers where in the contract drawings and specifications. The contractor shall provide all base supports and other mounting accessories necessary to complete the installation as further described herein.

1.03 REFERENCES

1. Drawings, other sections of these specifications, and general provisions of the Contract, apply to this Section.
2. National Fire Protection Association (NFPA)
 - A. Article 384 – Switchboards and Panelboards
3. National Electrical Manufacturer’s Association (NEMA)
 - A. NEMA AB 3 – Molded Case Circuit Breakers and Their Application
 - B. NEMA PB-1 Panelboards
 - C. NEMA PB 1.1 – Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less
 - D. NEMA 110 – Enclosures
4. National Electrical Contractors’ Association (NECA)
 - A. NECA 407 – Recommended practice for Installing and Maintaining Panelboards

5. Underwriter's Laboratories (UL)
 - A. UL 50 Enclosures for Electrical Equipment
 - B. UL 67 – Panelboards
 - C. UL 489 – Molded Case Circuit Breakers and Circuit Breaker Enclosures

1.04 QUALITY ASSURANCE

1. Panelboards and overcurrent protective devices shall comply with applicable requirements of NEMA, NEC, and UL standards for the intended application.
2. Panelboards shall bear the UL (UL) Label.
3. Panelboard installation shall comply with NECA Standard of Installation, NEC requirements and as specified herein.

1.05 COMPATIBILITY

All panelboards and associated overcurrent protective devices shall be the product of the same manufacturer.

1.06 MANUFACTURERS

Provide products in accordance with the specifications and manufactured by one of the following, or an approved equal:

1. Cutler-Hammer, Inc.
2. General Electric Co.
3. Square D Co.

PART 2 – PRODUCTS

2.01 – GENERAL

Provide panelboards, enclosures, and accessories of the types, sizes, and ratings required, which comply with the manufacturer's standard materials, design and construction in accordance with the published product information. The contractor shall equip with types and quantities of overcurrent protective devices and accessories as required for a complete installation.

Panelboards shall be UL-Listed and shall comply with UL, NEC, and established industry standards suitable to the application.

Panelboards shall be designed for convenient addition and replacement of switching and protective devices obviating the need to disturb adjacent units or main bus connectors, drilling, machining, or tapping the bus.

Panelboards shall be of the dead-front, safety-type with bolt-on molded case thermal-magnetic circuit breakers.

Panelboards scheduled to have main circuit breakers shall be configured with vertically mounted breakers, unless otherwise required.

Load-center type panelboards are not acceptable for this application.

2.02 BUSSING

Panelboard mains bussing shall be bare or tin-plated copper; bussing shall be full rated throughout the height of the panel.

Neutral bussing shall be full rated, and electrically isolated from the cabinet. Neutrals shall be K-rated for all K-rated panel applications.

Panelboards shall be furnished with a copper ground bus with a capacity of not less than $\frac{1}{2}$ the capacity of the phase bus. Ground bus shall be electrically bonded to the cabinet.

Panelboard lugs shall be designed to accept copper or aluminum wire.

2.03 BRANCH CIRCUIT OVER-CURRENT PROTECTIVE DEVICES:

Circuit breaker panelboards shall have automatic short circuit and overcurrent protective devices having an "ON", "OFF", and tripped position of the operating handle. Multi-pole breakers shall be common trip and so designed that an overload on one pole will cause all of the breaker poles to open. Circuit breakers shall be of the quick-make, quick-break type and shall have inverse time trip characteristics. Tandem mounted breakers are not acceptable.

All circuit breakers shall be clearly and visibly marked on the handles for their ampere trip rating. Panel and breaker designs where the panel trim must be removed to determine trip rating are not acceptable.

Circuit breakers in frame sizes larger than 100 A shall be manually operated with a mechanism for adjusting instantaneous and overload trip settings.

All circuit breakers shall have 75 degree C rated terminals, suitable for copper or aluminum wire.

Provide circuit breakers with switched neutral, ground-fault trip, arc-fault trip or shunt trip capacity where required.

Provide circuit breakers with handle locking devices to prevent manual breaker operation where required.

Where new circuit breakers are to be installed within existing panelboards, they shall be listed for use with the existing panelboard type and of sufficient amperage and short circuit rating for the application.

2.04 INTERRUPTING CAPACITY

Panelboard bussing, main, and branch circuit breakers shall be rated for the available fault current on the system. Panelboards shall be fully rated unless specified otherwise.

2.05 CABINETS AND TRIM

Cabinets shall comply with NEMA PB1. Cabinets shall be of code gauge, galvanized sheet steel and equipment, having gutters of sufficient size for risers and outgoing circuits. Cabinets and trim shall be thoroughly cleaned with trim finished per the manufacturer's standard unless specified otherwise.

Cabinets shall be rated NEMA Type 1 for dry interior areas and Type 4X for wet and exterior areas, unless specified otherwise.

Provide panelboards with a hinged door, combination spring lock and catch, directory frame and two 920 keys. Panels over 48 inches high shall be furnished with 3-point latches or multiple latches. All panel locks shall be keyed alike and a typed directory indentifying each circuit shall be provided in the frame.

Trim clamps, locks, and hinges shall be of the concealed type.

Panelboards shall be suitable for flush or surface mounting as required for the application.

Panelboards shall be supplied with lockable or screw-type, hinged, door-in door type cabinet trims.

2.06 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS:

Where separately enclosed molded case circuit breakers are required, provide circuit breakers in accordance with the requirements noted for panelboards.

Enclosed circuit breaker cabinets shall be rated NEMA Type 1 for dry interior areas and NEMA Type 4X for wet and exterior areas.

PART 3 – EXECUTION

1.01 INSTALLATION

Contractor shall examine areas and surfaces to receive panelboards for compliance with requirements, installation tolerances, and other factors affecting performance, and shall proceed with installation only after unsatisfactory conditions have been corrected.

Installation of panelboards shall be in accordance with Article 384 of the NEC, manufacturer's instructions and all relevant NECA requirements.

Panelboards shall be installed plumb and the top of the enclosure shall not exceed six feet above finished floor. For panelboards that exceed six feet overall, install in such a way that the bottom of the enclosure is no more than six inches above finished floor and the centerline of the top-most device handle doesn't exceed 6' - 6" above finished floor.

Furnish and install each new panelboard with a plastic engrave nameplate indicating panel designation, panel operating voltage/phase, source and circuit number of panelboard supply (for disconnection and isolation).

Where new circuit breakers are installed or loads added to existing panelboards, update the existing circuit directory with new typewritten panelboard circuit directories to clearly identify the loads served.

Anchor panelboard back boxes to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

All terminations shall be accurately torque per manufacturer's specifications using the appropriate torque screw driver or torque wrench.

Calibrate adjustable-trip circuit breakers.

Install filler plates in all unused spaces.

Measure steady state load currents at each panelboard feeder and rearrange circuits in panelboard to balance the phase loads to within 20% of each other. Maintain proper phasing for multi-wire circuits.

All panelboards shall be left clean and all debris removed from gutters and enclosures.

Inspect completed panelboards for damage, proper alignment, anchoring, and grounding; repaint all scratches and dings to match finish paint color. Verify proper installation and tightness of connections.

END OF SECTION

SECTION 16510**INTERIOR LUMINAIRES****PART 1 GENERAL****1.01 SCOPE**

Furnish and install interior lighting fixtures, wiring, lighting controls, and accessories to the extent fixture work is indicated by drawings and schedules. The contractor shall install occupancy sensors and photocells where required by the contract drawings to realize energy savings through light reduction at times of unoccupancy and daylight harvesting. In specified areas, the occupancy sensors shall also be wired into the designated VAV box to provide energy savings through reduced heating.

Types of luminaires and controls in this section include:

1. Fluorescent
2. Occupancy sensors
3. Photocells

Provide interior lighting fixtures which have been Underwriters' Laboratories (UL) listed and labeled.

Provide fluorescent lamp ballasts complying with Certified Ballast Manufacturers' Association standards and carry the CBM label.

Provide ballast meeting all applicable energy codes with a temperature rating suitable for the application.

1.02 REFERENCES

ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.

ANSI C82.1 - Ballasts for Fluorescent Lamps - Specifications.

NEMA WD 6 - Wiring Devices-Dimensional Requirements.

NFPA 70 - National Electrical Code.

NFPA 101 - Life Safety Code.

IECC 505 - Electrical Lighting and Power Systems

1.03 SUBMITTALS

Section 01300 - Submittals: Procedures for submittals.

Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

Product Data: Provide dimensions, ratings, and performance data.

Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

Submit manufacturer's operation and maintenance instructions for each product.

1.04 MANUFACTURERS

Acceptable manufacturers for lighting fixtures and controls, subject to compliance with requirements, shall be as called out on the contract drawings, or shall be an approved equal; accessories shall be as described herein.

PART 2 PRODUCTS

2.01 INTERIOR LUMINAIRES

Luminaires, lighting controls, and accessories shall be furnished and installed in accordance with the contract drawings and schedules. Luminaires shall consist of complete units including fixture, ballast, lamps, and associated components requires for a complete and operating unit with the options, finishes, and photometry of those specified. Lighting products and accessories shall be as specified, or an approved equal.

A. Recessed Parabolic Luminaires

1. Manufacturers:

Luminaires shall be Metalux HP3 Series as manufactured by Cooper Lighting, or approved equal. Recessed parabolic troffers shall be 2"x 4" in size and shall include, but not be limited to, a steel enclosure with die-formed stiffeners and end plates that attach to housing via interlocking tabs. Housing shall be suitable for lay-in, grid mounting and shall have end plates with an integral Grid-Lock feature for safety and convenience. A removable, contoured ballast/wireway cover shall be located in the center of the housing; captive lamp holders shall enclose lamp holder wiring to facilitate lamp holder replacement.

Luminaire housing shall be painted a high reflectance white. Louvre shall be silver with semi-specular finish with interlocking mechanism to secure parabolic cells. Two-lamp fixtures shall be equipped with a twelve (12) cell louvre (2 rows of 6) and three-lamp fixtures shall be equipped with include an eighteen (18) cell louvre (3 rows of 6).

Luminaires shall be equipped with the number and size of lamps and ballasts as indicated on the plans. Luminaire efficiency factor (LEF) shall be 76% minimum.

2. Description: Ceiling grid, lay-in, troffer-type luminaire equipped with number and size of ballasts and lamps as indicated on the plans.
3. Size: 2' X 4'.
4. Material: Sheet steel housing with white finish.
5. Photometric Control Elements: Aluminum parabolic louver, silver with semi-specular finish.
6. Photometric Performance: Minimum coefficient of utilization 0.65 at room cavity ratio of 2 with ceiling-wall-floor reflectance of 70-50-30 percent.
7. Efficiency: Minimum 76.5%.
8. Installation Conditions: Indoor use.
9. Mounting: Recessed, lay-in grid ceiling.
10. Ballast: Electronic, instant- start, normal power factor- 1.0 , THD <10%, matched to lamp characteristics, rated 120 VAC.
11. Lamp: Eco-friendly, ALTO low mercury, T8 fluorescent, bi-pin lamps suitable for rapid or instant start, 20,000 hour rated average life; size and quantity as per the contract drawings.

B. Enclosed, Gasketed Hazardous location Luminaires

1. Manufacturers: Simkar or approved equal.
2. Operating Voltage: 120/277VAC
3. Mounting: Wall

2.02 EXIT/EMERGENCY LIGHTS

- A. Manufacturers: Ruud Lighting EXD series Emergency Exit Light LED Exit Sign, complete with battery back-up and remote capability, or approved equal; operating range 19°C to 30°C (65°F to 85°F).
- B. All models must comply with NFPA 101 Life Safety Code requirements.
- C. Emergency Power: All units shall be equipped with a sealed, maintenance-free lead calcium battery to supply a minimum of 90 minutes emergency power; automatic low-voltage disconnect shall protect the battery from battery drain down and brownouts.
- D. Operating Voltage: 120/ 277VAC
- E. Housing: Flame-rated, UV stable, white, thermoplastic.
- F. Face: Thermoplastic stencil face with red 6" letters. EXIT letters to meet or exceed UL specified lumen output and illumination uniformity.
- G. Mounting: Universal for field selection.
- H. Accessories:
 - 1. Combination units shall be equipped with two (2) fully adjustable, 6 V., 3.9 watt, tungsten (T5 wedge base) lighting heads.
 - 2. Emergency Lights Ruud EM1 Series where shown on drawings.
- I. Test Switch: Manual test switch which transfers unit from external power supply to integral battery supply.

2.03 LIGHTING CONTROLS – SENSORS

- A. Photocell — [Sensorswitch CM PC].
 - 1. Sensorswitch On/Off Photocell Sensor, LowVoltage.
As specified in Article 2.6, Paragraph C.1, Sector Flex allows sensors to operate in an open-loop fashion, providing a stable day light control scheme by integrating the light within the space to maintain average light levels. Closed-loop sensors tend to look at a fixed point: as the status of that fixed point changes, the lighting in the space can fluctuate widely. Systems that depend on closed-loop sensors should not be acceptable on this project.

- a. Mounting: Ceiling tile
- b. Coverage: 360°
- c. Operating Voltage: 12-24 VAC/VDC
- d. Push-Button Programmable Control
- e. Digital Setpoint and Deadband Control
- f. Low Voltage Relay- dry contact SPDT, 1Amp, 40 Volt

B. Occupancy Sensors

1. Sensorswitch Low Voltage Dual Technology (infrared and ultrasonic) Standard Range Occupancy Sensor — [Sensorswitch CMPDT9R].
 - a. Mounting: Ceiling
 - b. Coverage: 360°, 12 ft. radial coverage when mounted to standard 9 ft. ceiling
 - c. Operating Voltage: 12-24 VAC/VDC
 - d. Options: Low Voltage Relay- dry contact SPDT, 1Amp, 40 Volt
 - e. Color: White
2. Sensorswitch Low Voltage Dual Technology (infrared and ultrasonic) Extended Range Occupancy Sensor – [Sensorswitch CMPDT10R].
 - a. Mounting: Ceiling
 - b. Coverage: 360°, 28 ft. radial coverage when mounted to standard 9 ft. ceiling.
 - c. Operating Voltage: 12-24 VAC/VDC
 - d. Options: Low Voltage Relay-dry contact SPDT, 1 Amp, 40 Volt
 - e. Color: White
3. Sensorswitch Low Voltage Dual Technology (infrared and ultrasonic) Hallway Occupancy Sensor — [Sensorswitch HW13].
 - a. Mounting: Wall
 - b. Coverage: Narrow beam, 130 ft. at 7ft. mounting height
 - c. Operating Voltage: 12-24 VAC/VDC
 - d. Color: White
4. Sensorswitch Line Voltage Dual Technology (infrared and ultrasonic) Wall Switch Decorator Sensor — [Sensorswitch WSD PDT].
 - a. Mounting: Wall, 30-48 ft. above finished floor
 - b. Coverage: 180°, 20 ft. radial small motion coverage, 50 ft. radial large motion coverage
 - c. Operating Voltage: 120/277 VAC
 - d. Color: White

C. Accessories

1. Sensorswitch Plenum-Rated Power Pack (AC Switching only) – [Sensorswitch PP-20]

- a. Mounting: Ceiling junction box
- b. Operating Voltage: 120/240/277VAC single phase
- c. Relay Rating: 20 Amps, AC switching only
- d. Output Voltage: 15VDC, 150mA at 120 or 277 VAC
- e. Plenum Rated
- f. Operating Temperature: 14°F to 160°F.

PART 3 EXECUTION

3.01 INSTALLATION

Exit Signs: Install Exit signs plumb and at height as indicated on the contract drawings. Adjust to align with building lines and with each other. Secure to prevent movement and position exit sign directional arrows to indicate direction of nearest exit.

Exposed Grid Ceilings: Locate drop-in ceiling luminaires as indicated on reflected ceiling plan. Support troffer luminaires with additional hanger wires at each corner using minimum 12 gauge wire.

Install accessories furnished with each luminaire.

Install recessed luminaires to permit removal from below.

Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

Install clips to secure recessed grid-supported luminaires in place.

Connect luminaires to branch circuits indicated on the contract drawings.

Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

Bond products and metal accessories to branch circuit equipment grounding conductor.

Install specified lamps in each luminaire.

Operate each luminaire after installation and connection. Inspect for proper connection and operation.

Install photocell and additional power pack along with occupancy sensor in designated rooms with daylight zone. Photocells shall be installed so that center lights of luminaires in daylight zone are automatically turned off when adequate natural light is present. The daylight zone is the area bounded by a parallel line 15 ft. from the glazing and two perpendicular lines drawn from 2 ft. from both lateral edges of the window.

In specified areas, run the occupancy sensor HVAC relay output to the designated VAV box; multiple relay outputs to a single VAV box shall be paralleled.

END OF SECTION

SECTION 16721
FIRE ALARM SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

This section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.

The fire alarm system shall consist of all necessary hardware equipment and software programming to perform the following functions:

1. Fire alarm system detection and notification operations.
2. Control and monitoring of smoke control equipment, and other equipment as indicated in the drawings and specifications.

1.02 SCOPE OF WORK

- A. The scope of this project is to provide a new Simplex addressable 4100ES fire alarm integrated into the AHU system.

1.03 ACCEPTABLE EQUIPMENT AND SERVICE PROVIDERS

Manufacturers: The equipment and service described in this specification are those supplied and supported by SimplexGrinnell and represent the base bid for the equipment. Due to compatibility with existing systems and Plant security no substitutions will be accepted. Contact Roger Henning (262) 825-1017.

The equipment and service provider shall be a nationally recognized company specializing in fire alarm and detection systems. This provider shall employ factory trained and NICET Level III certified technicians, and shall maintain a service organization within 50 miles of this project location. The equipment and service provider shall have a minimum of ten (10) years' experience in the fire protective signaling systems industry.

1.04 RELATED DOCUMENTS

Drawings and general provisions of the contract, including general and supplementary conditions apply to this section.

The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:

1. Division 15: "Air Handling Units with Coils".

The system and all associated operations shall be in accordance with the following:

1. Requirements of the following Model Building Code: IBC, 2003 Edition
2. NFPA 72, National Fire Alarm Code, 2007 Edition
3. NFPA 70, National Electrical Code, Edition 2008
4. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 2002 Edition 2009
5. Local Jurisdictional Adopted Codes and Standards
6. ADA Accessibility Guidelines

1.05 SYSTEM DESCRIPTION

General: Provide a complete, non-coded addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.

Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary.

1. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation.
2. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.
3. Panels shall be capable of full system operation during new site specific configuration download, master exec downloads, and slave exec downloads.
4. Panels shall automatically store all program changes to the panel's non-volatile memory each time a new program is downloaded. Panels shall be capable of storing the active site-specific configuration program and no less than nine previous revisions in reserve. A compare utility program shall also be available to authorized users to compare any two of the saved programs. The compare utility shall provide a deviation report highlighting the changes between the two compared programs.
5. Panels shall provide electronic file storage with a means to retrieve a record copy of the site-specific software and up to nine previous revisions. Sufficient file storage shall be provided for other related system documentation such as record drawings, record of completion, owner's manuals, testing and maintenance records, etc.
6. The media used to store the record copy of site-specific software and other related system documentation shall be electrically supervised. If the media is removed a trouble shall be reported on the fire alarm control panel.

History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.

Recording of Events: Record all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout differentiates alarm signals from all other printed indications.

Wiring/Signal Transmission:

1. Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation as required or addressable signal transmission, dedicated to fire alarm service only.
2. System connections for initiating device circuits shall be Class B, Style D, signaling line circuits shall be Class B, Style 4 and notification appliance circuits shall be Class B, Style Y.
3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.

Remote Access:

1. Fire Alarm Control Panel (FACP) shall have the capability to provide a remote service access feature using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3. The remote access feature shall provide automatic notification of system faults and remote diagnostics of system status for responding technicians prior to arrival on site.
2. A standard RJ-45 Ethernet connection shall connect to the owners Ethernet network. Provisions for that connection must be provided at each fire alarm control panel as part of the contract.
3. The Ethernet access feature shall be agency listed for specific interfaces and for the purpose described in this section. The use of non-listed external third party interfaces is not acceptable.
4. The internet remote access service function shall provide automated real time off-site reporting of discrete system events to a remote service support center with details of internal FACP fault conditions allowing a pre-site visit analysis of repair requirements.
5. Existing FACP controls shall be capable of retrofitting the remote service module as a plug-in upgrade feature.
6. The remote service network shall work on the customers Ethernet infrastructure and be Fire-Wall friendly for two-way communications for off-site reporting. The feature shall be compatible with existing proxy servers and firewalls shall not require any special changes or modifications.

7. The remote service system shall be able to connect to the remote service center without the need for a VPN account or similar tunnel.
8. The remote service system shall be a non-Windows based application to protect against conventional virus attacks.
9. The remote service system shall support a secure connection with strong encryption, 128 bit or better, and an optional secondary encryption method if required.
10. The remote service system shall be compatible with virtual LANS (VLAN).
11. The remote service system shall work on an outbound communication premise (panel calls home) in order to eliminate the possibility of any inbound connection into the network (from trusted or non-trusted sites).
12. The remote service system shall provide an audit trail of all events and service connections.
13. The remote service connection will provide access for panel software downloads and uploads for archiving job specific programs back at the enterprise server.
14. The supplier shall provide a service contract for the remote service program that provides the following requirements:
 - a. 24/7 recording of FACP service activity.
 - b. Off-site diagnostics by a technical specialist to provide repair and parts guidance to the service technician prior to a site visit.

Required Functions: The following are required system functions and operating features:

1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
2. Non-interfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
3. Transmission to an approved Supervising Station: Automatically route alarm, supervisory, and trouble signals to an approved supervising station service provider, under another contract.
4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the type of device, the operational state of the device (i.e., alarm, trouble or supervisory) and shall display the custom label associated with the device.

5. General Alarm: A system general alarm shall include:
 - a. Indication of alarm condition at the FACP and the annunciator(s).
 - b. Identification of the device/zone that is the source of the alarm at the FACP and the annunciator(s).
 - c. Operation of audible and visible notification appliances until silenced at FACP.
 - d. Shutting down supply and return fans serving zone where alarm is initiated.
 - e. Closing smoke dampers on system serving zone where alarm is initiated.
 - f. Transmission of signal to the supervising station.

6. Supervisory Operations: Upon activation of a supervisory device such as a low air pressure switch, and tamper switch, the system shall operate as follows:
 - a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
 - b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
 - c. Record the event in the FACP historical log.
 - d. Transmission of supervisory signal to the supervising station.
 - e. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.

7. System Reset
 - a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-alarmed the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
 - b. Should an alarm condition continue, the system will remain in an alarmed state.

8. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.

9. WALKTEST: The system shall have the capacity of eight (8) programmable passcode protected one-person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:

- a. The city circuit connection and any suppression release circuits shall be bypassed for the testing group.
- b. Control relay functions associated with one of the eight testing groups shall be bypassed.
- c. The control unit shall indicate a trouble condition.
- d. The alarm activation of any initiating device in the testing group shall cause the audible notification appliances assigned only to that group to sound a code to identify the device or zone.
- e. The unit shall automatically reset itself after signaling is complete.
- f. Any opening of an initiating device or notification appliance circuit wiring shall cause the audible signals to sound for four (4) seconds indicating the trouble condition.

Analog Smoke Sensors:

1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have seven (7) selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT display or printed for annual recording and logging of the calibration maintenance schedule.
5. The FACP shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
6. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.2-3.7% per ft. obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.
7. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.
8. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.

Smoke Detectors: A maintenance and testing service providing the following shall be included with the base bid:

1. Biannual sensitivity reading and logging for each smoke sensor.
2. Scheduled biannual threshold adjustments to maintain proper sensitivity for each smoke sensor.
3. Threshold adjustment to any smoke sensor that has alarmed the system without the presence of particles of combustion.
4. Scheduled biannual cleaning or replacement of each smoke detector or sensor within the system.
5. Semi-annual functional testing of each smoke detector or sensor using the manufacturers' calibrated test tool.
6. Written documentation of all testing, cleaning, replacing, threshold adjustment, and sensitivity reading for each smoke detector or sensor device within the system.

Audible Alarm Notification: By horns and strobes in areas as indicated on drawings.

Fire Suppression Monitoring:

1. Existing Fire Suppression System: The activation of the existing fire suppression system shall activate system supervisory operations.

Power Requirements

1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
5. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.

8. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.06 SUBMITTALS

General: Submit the following according to Conditions of Contract.

1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
2. Wiring diagrams from manufacturer.
3. Shop drawings showing system details including location of FACP, all devices, circuiting and details of annunciator.
4. System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate in accordance with the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.
6. Operating instructions for FACP.
7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
9. Record of field tests of system.

Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions, if required, to make clarifications or revisions to obtain approval.

1.07 QUALITY ASSURANCE

Installer Qualifications: A factory authorized installer is to perform the work of this section.

Each and every item of the Fire Alarm System shall be listed under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.08 MAINTENANCE SERVICE

Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of twelve (12) months, using factory-authorized service representatives.

Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the City. In addition, respond to service calls within twenty-four (24) hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.

Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.

Renewal of Maintenance Service Contract: No later than sixty (60) days prior to the expiration of the maintenance services contract, deliver to the City a proposal to provide contract maintenance and repair services for an additional one-year term. City will be under no obligation to accept maintenance service contract renewal proposal.

PART 2 PRODUCTS

2.01 FIRE ALARM CONTROL PANEL (FACP)

General: Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems". The following FACP hardware shall be provided:

1. Power Limited base panel with platinum cabinet and door, 120 VAC input power.
2. 2,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
3. 2,000 points of Network Annunciation at FACP display when applied as a Network Node.
4. 2000 points of annunciation where one (1) point of annunciation equals:
 - a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
 - b. 1 LED on panel or 1 switch on panel.
5. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FACP LCD display.
6. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output.
7. One (1) auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.

8. One (1) auxiliary relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
9. Three (3) Class B or A (Style Y/Z) Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
10. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
11. Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.
12. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
13. The FACP shall support up to five (5) RS-232-C ports and one (1) service port. All five RS-232 Ports shall be capable of two-way communications.
14. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
15. Programmable DACT for either Common Event Reporting or per Point Reporting.
16. Service Port Modem for dial in passcode access to all fire control panel information.

Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

1. The system shall have the capability to provide expanded content, multi-line, operator interface displays. The expanded content multi-line displays shall be Quarter-VGA (QVGA) or larger and be capable of supporting a minimum of 854 standard ASCII characters to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions. The QVGA operator interface shall provide operator prompts and six context sensitive soft-keys for intuitive operation.
 - a. Expanded content, multi-line operator interfaces shall be capable of providing the following functions:
 - (i) Dual language operation with Instant-Switch language selection during runtime.
 - (ii) Activity display choices for:
 1. First 8 Events.
 2. First 5 Events and Most Recent Event (with first and most recent event time and date stamps).

3. First Event and Most Recent Event (with first and most recent event time and date stamps).
 4. General Event Status (alarm, priority 2, supervisory, or trouble in system)
 5. Site Plan
- b. Equal or hierarchal priority assignment. In systems with two or more operator interfaces, each operator interface shall be programmable to allow multiple operator interfaces to have equal operation priority or to allow hierarchal priority control to be assigned to individual operator interfaces (locations).
 - c. Up to 50 custom point detail messages for providing additional point specific information in detailed point status screens.

2.02 REMOTE LCD ANNUNCIATOR

Provide a remote LCD annunciator, where required, with the same "look and feel" as the FACP operator interface. The remote LCD annunciator shall use the same primary acknowledge, silence, and reset keys; status LEDs and LCD display as the FACP.

Annunciator shall have super-twist LCD display with two (2) lines of 40 characters each.

Annunciator shall be provided with four (4) programmable control switches and associated LEDs.

Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.

Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

The LCD shall display the following information relative to the abnormal condition of a point in the system:

1. 40 character custom location label.
2. Type of device (e.g., smoke, pull station, waterflow).
3. Point status (e.g., alarm, trouble).

Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, silence and reset operation shall be the same as the FACP.

2.03 SMOKE DETECTORS

General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:

1. Factory Nameplate: Serial number and type identification.
2. Operating Voltage: 24 VDC, nominal.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
4. Plug-In Arrangement: Detector and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
5. Environmental Compensation: The detector shall provide a software filtering process that automatically compensates for environmental factors and component aging that affect detector operation.
6. Each detector head shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the detector head LED shall be on steady.
7. Each detector base shall contain a magnetically actuated test switch to provide for easy alarm testing at the detector location and for accessing detector status information. Off-normal conditions shall be indicated by specific identifiable detector LED pulse patterns.

Duct Smoke Detector: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions, where applied.

1. The detector shall provide on-board sensitivity drift compensation and dirt accumulation tracking.
2. A magnetic test function shall initiate an alarm and provide detailed diagnostic information using the detector status LED.
3. The detector shall provide a multi-function status LED indicator that indicates off-normal conditions by specific identifiable detector LED pulse patterns.
4. The duct housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC or an auxiliary alarm relay with two "Form C" contacts rated at 1A@ 28VDC or ½A@ 120 VAC resistive. This auxiliary relay operates when the detector reaches its alarm threshold. Relay shall be mounted within 3 feet of HVAC control circuit.
5. Duct housing shall provide a relay control trouble indicator yellow LED.
6. Compact duct housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.

7. Duct housing shall provide two (2) test ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke detector.
8. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
9. Each duct detector shall have a remote test station with an alarm LED and test switch.

2.04 STANDARD ALARM NOTIFICATION APPLIANCES

Horn: Piezoelectric type horn shall be listed to UL 464. The horn shall have a minimum sound pressure level of 85 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings.

Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

Audible/Visible: Combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 85 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings.

Notification Appliance Circuit provides synchronization of strobes at a rate of 1Hz and operates horns with a Temporal Code Pattern operation. The circuit shall provide the capability to silence the audible signals, while the strobes continue to flash, over a single pair of wires. The capability to synchronize multiple notification appliance circuits shall be provided.

Accessories: The contractor shall furnish any necessary accessories.

2.05 TEXT MESSAGING APPLIANCE

Text Messaging Appliance with Addressable Message Selection using IDNet Communications. Refer to drawings for quantity and locations.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:

1. Factory trained and certified personnel.
2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
3. Personnel licensed or certified by state or local authority.

3.02 EQUIPMENT INSTALLATION

Furnish and install a complete fire alarm system as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, Ethernet drops, and all other necessary material for a complete operating system.

Existing fire alarm equipment shall be maintained fully operational until the new equipment has been tested and accepted.

Equipment Removal: After acceptance of the new fire alarm system, disconnect and remove the existing fire alarm equipment and restore damaged surfaces. Package operational fire alarm and detection equipment that has been removed and deliver to the City. Remove from the site and legally dispose of the remainder of the existing material. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

Install manual station with operating handle 48 inches (1.22 m) above floor. Install wall mounted audible and visual notification appliances not less than 80 inches (2.03 m) above floor to bottom of lens and not greater than 96 inches (2.44 m) above floor to bottom of lens.

Mount outlet box for electric door holder to withstand 80 pounds pulling force.

Make conduit and wiring connections to duct smoke detectors.

Automatic Detector Installation: Conform to NFPA 72.

Ethernet Drop: A standard RJ-45 Ethernet connection to the City's Ethernet network shall be provided at each fire alarm control panel as part of the contract.

3.03 PREPARATION

Coordinate work of this section with other affected work and construction schedule.

3.04 WIRING INSTALLATION

System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the authority having jurisdiction and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).

Contractor shall obtain from the fire alarm system manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the contractor without the prior written approval of the fire alarm system manufacturer.

Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

3.05 FIELD QUALITY CONTROL

Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:

1. Factory trained and certified.
2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
3. International Municipal Signal Association (IMSA) fire alarm certified.
4. Certified by a state or local authority.
5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the drawings and specifications. Correct deficiencies observed in pretesting. Replace malfunctioning equipment.

Inspection:

1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.

2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

Acceptance Operational Tests:

1. Perform operational system tests to verify conformance with specifications:
 - a. Each alarm initiating device installed shall be operationally tested. Each device shall be tested for alarm and trouble conditions. Contractor shall submit a written certification that the fire alarm system installation is complete including all punch-list items. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified. Test supervising station signal transmitter. Coordinate testing with supervising station monitoring firm/entity.
 - b. Test each notification appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
 - c. Test fire alarm control panel and remote annunciator.
2. Provide minimum ten (10) days' notice of acceptance test performance schedule to City, and local authority having jurisdiction.

Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the specifications and complies with applicable standards.

Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Use NFPA 72 Forms for documentation.

Final Test, Record of Completion, and Certificate of Occupancy:

1. Test the system as required by the authority having jurisdiction in order to obtain a certificate of occupancy. Provide completed NFPA 72 Record of Completion form to City and authority having jurisdiction.

3.05 CLEANING AND ADJUSTING

Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.

Occupancy Adjustments: When requested within one (1) year of date of substantial completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three (3) visits to the site for this purpose.

3.06 TRAINING

Provide the services of a factory-authorized service representative to demonstrate the system and train City's maintenance personnel as specified below.

1. Train City's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of eight (8) hours' training.
2. Schedule training with the City at least fourteen (14) days in advance.

END OF SECTION